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LOVE-LIFE IN NATURE

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The Story of the Evolution of Love

By

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Translated from the German by

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VOLUME ONE

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PREFACE

My book is addressed to all rational people who have the courage to form a philosophy of life for themselves. The world is a tough place and he who would pass through it must fear neither heaven nor hell. Of course, I refer to mature persons. But by mature persons I mean those who have experienced the hour of awakening, when the impulse for knowledge has stirred within them, when they realize that our fleeting human existence, our mad chase through the few years of our life with all its deceptions, is utterly vapid unless we give it a higher significance through knowledge, through that little candle, thought, which has been granted us to light our way in the gloom.

He who seeks and strives to impart knowledge goes through life naked, with but one garment to clothe him, truth. But with a tread sure as iron he makes for a solitary beacon, and for him misunderstandings are impossible. If I would rescue a drowning man, I pull off all my clothes and do not care a rap if anybody objects. We are all drowning men. Indeed, within each man there is a drowning man whom he himself must save, by the nakedest utterance upon all things in heaven and on earth just as they are.

For those who bring the necessary earnestness to the situation I need not adopt special solemnity of tone. An artificial assumption of dignity is an absurdity when pure, genuine human beings get together.

My book lays no claim to being a mere popularisation in the conventional sense of scientific material that others long ago collected and verified. To be sure, it uses a great mass of scientific, especially biologic, details which, in the present state of knowledge, may be regarded as positive facts. It is during the many years I spent in special investigation that I picked out this framework, more or less successfully, from the vast field of modern literature on the subject. Anyone in a measure familiar with this literature is aware in what a constant state of flux it is, how things grow obsolete under one's very eyes, and how their changeability often compels one to practice, as it were, enforced abstinence in observation. Thereby

we generally gain in calm and obtain a better summary view, though with some danger of loss in substance. But a goodly portion of the facts I use may be discounted, and yet, I believe, a solid remnant will remain sufficient to support in the main the logical sequence of my ideas.

In the present revised edition I tried, to as large an extent as my knowledge of the special literature permits, to test most of these framework facts again. I also supplemented them with additional facts. One will not reasonably demand that all the difficulties in this respect should be completely overcome. Besides, the purpose as a whole renders it unnecessary.

For here we have the other, the *essential,* side of the book. It uses the whole of the frame-work merely for a unified system of thought involving the values of a philosophy of life. I alone am responsible for this the real content of the book, whether it meets with favor or disfavor. My book is not a popularisation of scientific facts, but a subjective creation of my own.

As to the external form, I never felt the least hesitancy. I was convinced from the first it would have to be chiefly æsthetic. The bridge connecting the field of the strictly scientific, in which true and half-true facts are assembled, with the world of sovereign thought, which seeks the whole, leads across art, art with all its instruments, even humour. I have deliberately given the floor to humour when having to deal with subjects that the faint-hearted call "extremely delicate," convinced that Humour is the naïve child from whom we can hear such things with the least offence. For a similar reason I have adopted a tone of familiarity with the reader, not for the insipid smugness it lends a story, not as a mere caprice, but from a deliberate design to impart the artistic flavor peculiarly appropriate to the subject-matter. After a lapse of several years since the first appearance of the book I see no reason to make changes in this regard.

This book, the gift of an inspired period following upon years of severe study and travel, is now leading its own love-life in the world. May it continue its wanderings with renewed courage and further contribute its mite to the noble idea that humanity has at least one place in this world of sorrow and darkness where it need feel no shame: under the Tree of Knowledge.

WILHELM BÖLSCHE.

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PART I

FROM THE DAY-FLY TO THE MADONNA

'The Indescribable,
Here it is done:
The Woman-Soul leadeth us
Upward and on!

FAUST

LOVE-LIFE IN NATURE

§ 1

A soft white sheen lies over land and sea
And, free from clouds, the ether floats like vapour.
GOETHE (*Nausikaa Fragment*)

I SHOULD like to carry you off to a lovely spot; and there I should like to tell you a story. . . . East of San Remo, in the paradise of the Riviera, towers Capo Verde, a brown rock jutting out against the open sea. Strata of stone, that once were soft ocean bottom millions of years ago, crop out of the soft green contour of the coast like a phantastic citadel. The blue Mediterranean exposed them, wearing them away, not with rough fist, but through an infinite length of time touching them over and over again as in a dream with delicate white foam hands. Now the eroded, bared heads of strata lie there like pieces of the skeleton of a long extinct giant animal, whose grave has suddenly opened on the border of the sea. Between them, they form niches of soapy green, where the shallow water moves lazily and where, on the flat bottom, mysterious violet-red shadows of waving sea weeds loom up and fade away. At the outermost rim of the cliff the foamy coronet of the free onrushing waves flashes incessantly like dazzling white wings that close and spread fanlike in the sunlight. Beyond, far as the eye can see, all is blue; deep and bewitching blue. . . .

On the height of the cape, separated from the cliffs by an open sunny slope, on which the blossoming broom bushes hang like golden balls, and over which the violet thyme strews its hot dusty perfume, stands a solitary little church with yellowish white walls and a pale red roof: the Madonna della Guardia.

A regiment of ancient cypresses stands on guard around it, planted remote from the world amid this display of bright colours, like fate's raven feathers, motionless on their pale quills before the infinite blue perspective beyond the glowing yellow rock. Near the church is an equally simple inn, snow-white with grass-green shutters. A

few shaky tables and a good drop of home-grown wine. Bending down the slope toward the inn a fig-tree, only now, in April, puts forth its tender green sprouts that everywhere reach out of the thick grey branches like delicate little polyp fingers.

It's good to be here.

The eye roams from the dazzling blue of the sea off into the valleys and the hills, further inland. Everywhere the leafy coronets of olive trees scattered like dull, silvery clouds on emerald terraces to which the luxuriantly blooming dandelion lends a soft golden tinge. Nearby, a solitary old wind-cursed olive stretches above a ridge, a silhouette before the azure of heaven, as classical a form as if an artist's eye had contrived it. Far off, where the olive trees merge in a grey bank of clouds, here and there a toy village, small, white and red. Yellow walls of quarries, where the hills grow steeper, topped by plush-black woods, then violet heights where everything flows together in one colour tone. Finally, above the most delicate violet blue, a few peaks with piercing white snow.

A pale yellow, black-striped butterfly floats dreamily in the air. From the sea comes a very gentle breeze, soft and yet forceful in the absolute serenity at this height, where everything comes from infinite distances beyond the sea and travels into the infinite spaces of the sky.

And now the sea itself. Pale milky blue in this noonday glare, with stripes of almost pure white, off in the distance near the high sea melting into the infinitely delicate whitish-blue light of the horizon. There where the sun stands above it, a glory of silver. Here, nearer the shore, silver tinsel set in a soft sweet blue. Far away, a giant lake of softly shimmering silver unmixed with blue.

Into the heart of this silvery mass there now moves a tiny sail. Itself silver, only a shade less transparent, it floats like alien light in light, ghostlike, released from the hard world of colour like the Flying Dutchman of an eternal glittering sun-dream that rises only at a midday such as this. When the silver lustre between ocean and heaven is almost too much for mortal eye. . . .

Here let us speak of love.

Do you know an ancient book, of the early days of Christianity, the philosophical dialogue "Octavius" by Minucius Felix? It is, perhaps, the most amiable of primitive Christian apologies, simple, without any proselytizing taint. In a period of turbulence, when

the earth shook under the arms of Cæsar and the new faith was prey to the panthers in the arena, the philosopher led his friends to the blue sea, by the shore at Ostia. They stretch out on the soft sand, seek the gay shells and vie with each other in skipping flat pebbles over the silver surface of the waters. In the stillness of this simple picture of Nature, all the storm and dust of the world seems to be blown away, as if banished behind an invisible magic barrier. "And here, in this good place," so it reads, "we talked about God." So let us speak of love.

In our time, too, a tempest is raging. All things are in turmoil; the simplest questions are matters of dispute. World conceptions are overturned; a mighty cloud of dust envelops our time. Who is there who has not felt the longing to draw a mysterious wall about himself when he wanted to ponder . . . to ponder a great world problem? . . .

I should like to discuss many things with you. The rise of love through the ages. Its beginning and growth in animals and how it became human, human in its crudeness, human in its spirituality. I shall have to speak to you of coarse things and pleasant things.

But look out into the boundless brilliance of the sea. Out of this spotless blue, life emerged, moving and changing in thousands and thousands of forms and rising up even to you. Look into the firmament above and behold its infinite dazzling purity. Out of this blue of eternal space the worlds rained down like silver dust. How many alarming, horrible things the depths of this flood concealed, and still conceal. And yet, on the whole, it is a wondrous blue, into which the soul dives as into a bath of peace. Is this not a symbol to us? A symbol of how all the crudeness of the individual must finally merge in pure harmonious unspotted light? And the heavens above. Those heavens which hold so much of struggling humanity's longing, despair and sin, as if each star were a tombstone; this sky that really clasps us all like a coffin—shuts down us sorry guests on the dark earth . . . does not this sky too dissolve into the same blue of spotlessly pure glory?

I fancy that in a place like this you and I can speak as if in retirement, as if all the storms of the world had blown over and we two human beings were playing with the most sacred questions as simply as with flat pebbles that one skims over the water. One can talk, too, of all manner of crude and wild things, as if everything were already nearing dissolution into the eternal blue and

merely hovered over us like a delicate silver cloud, like that silver ship trembling yonder on the gleaming waters. . . .

You and I are two reasonable human beings that understand one another, are we not? Let us enter into a compact that we will let no obstacle in our way frighten us off and no ghosts, be they never so mad, shall keep us from journeying a stretch together on the road of truth. From the blue to the blue. What lies between, let us accept courageously with the humour that lies in the innocent simplicity of a child.

Let us talk of love.

Of love in the world, so far as this world is within our ken. Let us talk of it courageously and modestly. We are living in other times with other signs than those of Minucius Felix of old. He, too, when talking of his God with friends on the beach of Ostia, thought of love. But love to him had become a supernatural wonder. Love on earth had then among the fallen, sinning, tortured mortals, seemed bankrupt and dead. Out of the mystical blue beyond all known reality, it was to descend again, in opposition to Nature, overthrowing its own innermost life. No bond uniting the here and there; natural development was sin and perdition; light was wholly in that mystic twilight blue apart from the world.

Two thousand years later, and in mankind, a young, fiery spirit struggles upward; scientific research, knowledge, the divining and seizing of the old world of reality as a new possession! For the first time there awakens with its entire strength the consciousness of a world without a curtain, without a rift, without mystical ambiguity.

Look at the little white church over there between the cypresses that are as black crows. That is the age that has died away, still reaching into our days. In the yellowish little tower with the little cupola hangs a bell, green with age; it rings of love that is not of this world. But look more closely.

The cross, that stretches from the cupola into the boundless wondrous blue, runs at the top into a long suspicious-looking point. A lightning rod. The double insurance of the new age: over the cross of mysticism, the metal shaft that tames the bolt of heaven with the knowledge of physics, of science . . . may the old green clock call, when the black thunder cloud swoops down upon this open height like a bird of prey and claws with flashing fangs—the lightning rod is stronger; it is the cross of our times.

If we are to speak of love, it must be a different speech in these different days. Follow that beautiful butterfly yonder; how majestically it sinks down to the thyme. Out of animals lower than this hovering butterfly, you, man, have come into being, you the man of modern knowledge. Your race came up from primordial beings much more incomplete even than this mute motionless thyme bathing in the burning sun. *You* were grotesque creatures without a trace of your form. They crawled on the shore of the sea when this shore was still soft ooze, which to-day forms those adamantine ridges of rock, on which the blue waves break in foam. And what connects you with all these creatures that were *you* and yet not you, æons ago, is the mighty cosmic force of love, of procreation, of the eternal process of birth and coming into being. Thousands and thousands, aye, millions and millions of times you have loved, suffered and bled, have been crucified, have died and yet have risen again on the third day. There in the past, in the immeasurable chain of all these ante-egos of your own ego, here peacefully enjoying nature on Capo Verde lies the solution of all your problems, of your profound secrets that are spun through you like a dark net of fate, like a black cobweb, to which your tears cling like dewdrops.

There, too, lies the solution of your love. The butterfly, that now lies motionless on the violet flowers as if intoxicated by all the sunshine, tells you more of love than all the green bells in the world. Let me tell you about the butterfly and his kind from the new signs, that no age before ours ever possessed.

But first close your eyes for a moment.

Let this quiet picture disappear—the solitary little white church with its cross and lightning rod, the black cypresses, the silver and blue sea. Let everything grow dark, and hark back in your memory.

So that you will understand the gist of what I want, I would recall two experiences in your life, experiences that recur and fade away. Two moments, when you lost yourself in love, lost it in the utter felicity of pulsing life without a trace of the fear of death, when you died as your "self," but died into life. Once in the body. And once in spirit.

Remember. . . .

You experienced love, enjoyed love in your life, the love of the senses. Coarse pictures, or at least pictures that you once considered coarse rise before you. But wonderfully sweet ones, too.

You think of the fears and mistakes of your youth. Of wretched hours that pitilessly trod in the dust the gold of your dreams. And yet, of golden hours, too, that made a new man of you, raised far above the most exalted hopes of all your inexperienced dreams. Those were the hours of truth in your sensual love. They are sacred as is every genuine hour of truth. They are hours when a feeling came over you like a harsh glare that yet is radiant light, light that forges souls and melts the ores out of the dross. . . .

Your ego sank with your senses into another ego. It rose again, and you became you again. But one fine day, a new ego came. Blue baby eyes looked at you with something of yourself in them. A mysterious new life, a new human being, which yet encompassed a part of you . . . the great mystery.

Remember. . . .

Other hours followed. You lost yourself again, but differently.

In spirit you were merged in another being. Your souls melted into one. Whether man, whether woman is all the same.

But this time your love did not confine itself to the one person. It embraced all. It became love of mankind. Holy objectives in the distance snatched you out of the confines of your narrowness. Your ego became the chord of a melody. And this time, all in the spirit.

And out of the spirit that streamed over you, there grew new dreams, ideals, creations. A new blue heaven, out of which worlds ran like silver dust. A union of minds, a life beyond the individual, into which your children will once grow when their intellects awaken, when their egos are ripe to sink alive in the great melody.

These two moments you recall, are they not the greatest, the most wonderful thing in your life? What power came over you and tore your ego into this profoundly mysterious loss and resurgence of self?

I want this recollection and this question to be our starting point. The main outlines of what we are to discuss must be within you in the form of your deepest experience. You must have gone through the hour of enlightenment twice in your life, when a veritable shower-bath of light descended upon you: the knowledge that in these highest blessed moments of love a flood of sin did not overpower you, but that something holy came close to you that was greater than yourself, a deep blue cosmic wave, that once carried you aloft and that now has rolled past you.

Only in this way can my speech hold you. If you always think of yourself in the course of it. This narrative is about you. Everything comes to you in the end. In love, you are the world. And the universal history of love, which I shall tell you, is in this sense only a chapter of your own history. A primitive recollection, going back in the æons of space and time, going back to all the ancient brothers of the animal and vegetable kingdom, going back in thought to return to you for the act: when you love.

Look out upon the sea again . . . ever deeper sinks the noonday stillness upon the blue before us. Only a very faint-hearted twitter from the birds in the silver olive trees. A dull roar, as if dying away into the ground: it is the train hurrying through the tunnel under Capo Verde. A faint sound of chimes from the villages in the valley. Butterflies everywhere, now rocking dreamily, inaudibly over the golden broom and the violet thyme. An exhalation of purity lies over land and sea, like the first morning of creation. We no longer believe in creation. We believe in generation. Generation in the eternal cycle of Nature's laws. Generation through love. Thus the world is an endless spring day. Let us walk then from this spring, that encompasses us here with such ineffable sweetness, a little way toward the sunlight of that eternal spring. . . .

Three pictures arise within me as I look down into the shimmering silver blue sea. I feel as if it contained the entire road that the history of love has travelled. In three stages.

Truth puts all ignorance to flight;
Naught can withstand the searching light
Of intellect set free.

Paralipomena to Faust

§ 2

And if thou hast not death and birth
Thou art a cheerless thing on earth.

GOETHE

It is a wild summer evening at the river. The sultry air broods on the earth. Heat lightning darts across a distant bank of clouds. The moon hangs over the dark waters like a menacing red poppy.

This is the hour of the resurrection of a strange race. Silently, ghostlike, tiny, delicate forms rise out of the stream so delicate and transparent that each seems but an atom of colourless light.

First there are only a few, fluttering away and losing themselves in the sultry haze, then more, many more; then thousands, myriads, as if the grey flood had become a springtime tree, pregnant with blossoms, shedding an infinite number of snowy petals into the air.

The far-off church tower, over the dreamy fields, strikes nine.

As if a magic force were in this hour, all these little beings are drawn up over the smooth rigid mirror of the flood into the hot evening air . . . little silver wings flash up, flutter like veils of mother-of-pearl, sink down, merge into one another in the crush, and in the surge of moonlight melt into a soft scintillating cloud that illumines the dusky waters. Raining down infinite moon-lit flakes this cloud floats over the entire breadth of the stream to the bank, where the alders sleep, and hangs on the black branches like luminous foam . . . foam from which arises Aphrodite, the goddess of love.

All these swarming elves of the storm are insects of the day-fly family in the stage of their last transfiguration, animated by the all enrapturing intoxication of love, in the copulation swarm which is the crown of their whole existence.

Every one of those Bacchantes dancing in the silver haze up there has a long period of work as an individual behind it. For two or three years it was active in the ooze or the sand of the bank as an ugly, greedy larva, eating, swelling up, shedding its skin, a wild ruthless robber despite its small size, fighting day in and day out with the most tenacious energy for its existence as an individual.

The time was long enough for this little, rough, snappish animal to acquire all manner of experience in the struggle for existence. Always in danger, always liable at any moment to be eaten up or to die of hunger, it nevertheless by extreme effort finally survived and achieved a certain measure of vitality and character.

Then suddenly, toward nine o'clock on this sultry August evening, a rift through its entire existence more wonderful than death; a resurrection into a new form, into a new element, and a totally new objective. . . .

A sudden last shedding of the skin metamorphoses the body's larva form that was adapted to life at the bottom of the water into that crystal-clear sylph form which, now bathed in moonlight instead of by the turbid flood, scintillates over the waters like liquid silver. The supreme purpose of the old life, the consumption of food, has vanished with the old body; the new creature's delicate, winged body no longer possesses any serviceable masticating organs whatsoever. The years of preying, throttling, devouring, with their devastating struggle, are of a sudden blown away to nothing. But in place of them, there are new organs that stir longingly in the transparent elfin body: the organs of love.

And life, no matter how long or how short it may now still last, has a new purpose.

It reaches out beyond the individual.

The shimmering cloud of winged airy beings, light as a feather, rising in the moon mist is no longer an army of hermits, which only chance appeared to hold together in the depths of the mind—just as through yonder thunder cloud the electricity quivers and wells up in spasms, so through this entire cloud of floating insects there wells up and quivers one single ineffable longing for union, for fusion of the individual with a second, in overflowing love bliss, that melts all individuality and finiteness into the community and infinity of the race . . . all want to become two, and in the fervour of this desire, all the hermits become one single blessed wave of unselfish sociability . . . ever new brothers and sisters bob up out of the black yawning abyss, up into the glory of thunderstorm air and moonlight transfiguration, and in the breeze, in the dizzying whirl of the countless crowd, pair after pair seize each other and, amid all the paroxysms of supreme bliss which this tiny organism, delicate as a flower, can endure for a moment of completest de-

liverance and harmony to the very end, they consummate the great act of their new purpose, copulation.

Over the hot, parched fields, thirsting for the dew of the thunder-storm, the village clock sounds again; it is ten. The love-storm of the insects has now reached its climax. On the surface of the stream, the elves that arise and sink down form white islands of light, that incessantly part asunder and come together anew. The cloud whirls down on the paths of the river bank like the heaviest snowstorm. You yourself, a solitary wanderer, are instantly cloaked in it, covered with it, so that you have to make your way with difficulty. A row-boat vanishes under the living veil. The steps leading down to it are alive, several inches deep, as layer after layer piles one on the other in the ecstasy of flying, of breathing air, of finding one another, and of passionately released, paralyzing sensual pleasure.

But in the midst of the upward movement there is already noticeable a sinking tendency. Pair after pair has finished its work. One moment of supreme delight, and spring is gone. Now they swirl down like withered leaves. The female throws the fertilized eggs into the stream, and dies a sacrificial victim; as if the poor, soft sylphlike body had been struck to death by too much happiness; joys of love and of motherhood all crowded in the space of a single short moment. Blown far away by the first puff of air coming from the thunder cloud, the male, too, perishes simultaneously, killed by the lightning of love, that forced its senses to their pinnacle, but then took them away again for ever in this storm, and broke to bits this whole weak life at the very moment when all its strings sounded their mightiest melody in a harmony never before attained. . . .

The first distant thunder rolls. Softly singing, the wind falls among the bulrushes along the bank. Eleven o'clock. The ghostly apparition of elves is over. The black surface of the stream, restlessly pushing on, has swallowed up myriads of white corpses, swept them down-stream, a holiday meal for the little silver fishes of the deep. The rain will beat down the last weak stragglers, already branded by death. Two hours—and all the nuptial intoxication is gone, all the purposes of the new being are fulfilled to the bitter end, even unto death. And in the midst of this Festival of Bacchus, this same death reaps, sheaf after sheaf, until the last

glittering little particle of silver dust is returned to the old native flood and is carried away with the current into the deep night. "Blessed creature," says an ancient Greek, "it lived so rapidly that, save for death, no pain of its own could reach it any more, no sight of another's pain could make it suffer."

Two hours. But in these two hours of an evening of thunder-storm, the species was transmitted again for years to come. The fertilized eggs that sank without a sound in the depths of the water, like the thousands of corpses of love, but themselves no dead bodies, being full of the liveliest kind of life, will in the mysterious course of coming into being take the form of new larvæ. And then, years later, once more resurrection, Bacchanalian storm, love's fulfilment and sacrificial death.

Two hours.

But in these two hours a drama was enacted on which millions of years looked down.

The day-fly is older than you, older than man. Its wedding dance rises through the infinite reaches of the earth's history. The blue sea of the Devonian period saw it, when no mountain stood, no river flowed as to-day. It was among those present when the living wind still roared through forests of ferns and grasses, tall as trees, that now warm our hearth as coal. A white cloud of light, flashing in the moonlight, just as to-day, these love-thirsty elves bloomed out of the waters in the jurassic period that was so rich in adventure; when the ichthyosaurus swam and the bird-reptile archæopteryx fluttered through the air. And their brief life's wondrous dream remained the same when, in place of the ferny palms and the Araucaria of the jurassic period, the pine woods of the Tertiary drooped their boughs over their river; boughs that wept golden resin, later on petrified to become amber, which at this day often shows you embodied therein the sylph's body of a primordial day-fly.

Only in the Tertiary did man start. In all the thousands of years of his ascent, from the wild stone age side by side with the mammoth and cave bear to the loftiest hours of consecration of a world civilization becoming verdant, the eternally identical cycle of the day-fly accompanied him along the lonely stream, the quiet brook. It swarmed up in two hours of a moonlight night when first he read in the stars on the banks of the Euphrates, when

he brooded over the mystery of life on the Nile, when on the Ilissus he created a higher, shining world of rhythm and marble as a substitute for this world of tribulation and darkness.

And always the same thing. Always this dying of the individual for the race, this same delirium of the senses, crowded together into a tiny space of time, this sudden dark change of purpose. . . . Thousands of years, millions of years, intervals of time in which the constellations shift, in which the sun's wandering in space, the intrinsic motion of the fixed stars, the gentle changes in the earth's orbit and the earth's position, spread over colossal periods of time, become visible like great milestones: and every two or three years in this unbounded succession, two hours in which the fate of the species flies like a ball hurled by one generation to the next. Two hours, in which the individual, almost at the moment of its death, still becomes part and parcel of world history, a link in a chain that extends upward and on, from the first days of creation, between long-lost forests of fairyland, between stars that long since ceased to glow or that have strayed away, down to our own day.

The day-fly does not think. It awakens, whirls about, is filled with bliss and dies.

But you, the solitary, late, infinitely high-vaulting descendant of all these lower orders, you stand on the bank and stare after the little pale corpses of love, and in this dance of love and dance of death you meditate upon the mystery. . . . What is love?

Always lightsome, never tiring,
Spell-impelled thy wings to ply,
Till at last the light desiring,
Thou are burned, butterfly.

GOETHE

§ 3

It's over! Another picture. After the tragically sweet, a grotesquely rough one, but to the selfsame tune. Do you hear the wind whistle and the waters splash? Norway. The sharp sea air plays with its salty breath and fish smell. The waves dash on the granite coast. The primeval coast. Here already towered a giant fortress when the rest of Europe was still a coral archipelago around which the jurassic dragons swam. From here the ghastly glacier wall of the ice age later rolled over dying, deserted, freezing Northern Germany. A great, threatening magic castle of the earth's history, rich in mysteries, down to the days when the dragon ships of the Vikings plunged out from here into the unknown foamy desert of the vast terrestrial waters, toward the red flaming volcanoes of Iceland, toward the green grape-vines of mythical America of the year 1000.

Ghosts in the air! Rain clouds hang heavily upon the land. The rocks stand out naked in the pale hard light. Something in the sky and waters seem to augur the approach of an inconceivable spectre from the sea. Is it the Flying Dutchman, which the legend speaks of, with pitch-dark rigging outlined against the sulphurous yellow sky? Or the hand of Satan of the seaman's tale stretching its colossal red claws over the foaming crests of the sea? The sea-birds are uttering their anxious cries.

Ghosts in the air. What hasn't been washed up for mankind on this particular coast, in reality and in dreams! Here first man made his more intimate acquaintance of the whale, the gigantic mammal of the open sea. Here was spun the legend of the kraken, the sea-monster that rose out of the abyss like an island and sinking again dragged down to destruction the largest ship in its colossal spider arms; the legend whose solution was finally found in the giant cuttlefish in the chasms of the sea. Here again and again was seen the sea-serpent with flowing mane and horrible endless convolutions that made the green waters of the fjord seethe; a secret as hoary and old as the existence of seafaring peoples, yet still without any logical explanation. In the chasms of this sea,

there where at some distance from the rocky coast the bottom precipitously falls into a hideous valley, as if the ocean were sinking down into a deeper, second ocean, closer to the earth's core, dwells the hair-star, with a feathering whorl on a slender, firmly rooted stem like one of those wonderful lilies of the bright coral grounds; in reality, however, an animal, strange in its day and generation, a solitary straggler out of the blue wonder sea of the cretaceous period, where the gigantic sea-lilies swayed like shimmering palm-tree forests of the deep and offered the monstrous reptiles of those days lurking-places as the Indian jungle does the Bengal tiger to-day. . . .

Is some one or another of these wonders of the sea approaching the strand again?

Twilight lowers its cool colour tones over the sea. But now the waters themselves glimmer, like a magic gleam that coming from a lofty mirror seems to drag along toward the old granite coast. The silver sheen paints the air above; high up in the silvered haze one sees it approaching. Thus is the proximity of advancing crystal masses indicated in the sky to the polar explorer. But this time it is no ice that approaches. It is the silvery glare of a many-headed living thing, that presses on, closer and closer.

Not a single sea-monster but a compact silvery island of animals.

The herring draws near, united in millions.

The gleam of light that illuminates the fog is the reflection of the countless glittering bodies which the storming mass forces to the surface, yes, even out of the waves, till here and there the whole arches like a giant turtle, whose shining back reflects the moonlight. But never was there a turtle of such dimensions, not even in the remote days of incredible fabulous monsters. The island of living fish extends five miles in length as well as breadth. Swarms of white sea-gulls hover over it, as if it were one of those solitary cliffs in the ocean that serve myriads of noisy sea-birds as nesting place. Now here, now there, a single body flashes up, as if bluish-white flames played out of the excited, roaring element; as if the island wanted to discharge itself in volcanic convulsions.

Even so would it be if a giant hand stretched a net straight through the belly of the ocean and now rowed slowly with it toward the coast of the mainland, crowding together before it every living thing in that huge space swarming with fish, until the contracted element could no longer hold the mass, and the tangled mass got

jammed up against the shore, like a huge pyramid of living, quivering material, in all the mad, grotesque forms of the deep.

The giant is love.

The herring is otherwise lost in the ocean, like a mote in a flood of sunlight. Human research has hardly been able to determine, even to this day, where it conceals itself in the calm, passionless periods of its life; whether in the deep chasms of submarine valleys or, more probably, at certain open depths of the freest high seas, far from land.

Then all at once it is as if the trumpet-call of the old Prophet's vision resounded, the same that caused the bones in the valley to gather together. Through the innermost marrow of all these solitary scattered creatures there quivers a dark longing for closeness, for the flat surface between cliffs, where many can press themselves together voluptuously. Memory pictures of earliest infancy are in it. They were all born once near to the shore, in its close confines before they found the wide open ocean. Who can suspect to what tangible shape of specific localities this pale picture grows once more in the sudden, profound excitement of the entire organism! Certain it is that a complete transformation in all the habits of life now ensues. The herring presses on to the coast. Soon whole shoals are together; the common goal does not let them get away from one another. School joins school. It is all an immense dull mad stampede swimming blindly in one direction; a dizzying spectacle, if you picture the immeasurable spaces of the ocean, out of which love strains its masses. Finally the bottom becomes flat; the longed for coast is near. All radii now converge on one focal point . . . and out of the dark waters shimmers the silver island of the millions, throwing its searchlight even to the fog clouds.

But the colossal mass of fish gets jammed. The closeness with which they are pressed and squeezed together suddenly releases the whole restrained voluptuousness of love in a form that like this massed tempest has something almost brutal, in any event something gigantic about it. Thick clouds of male seminal fluid pour through the briny flood; clouds that are so tremendous that the ocean becomes turbid far and wide, and the whole silver island of voluptuously agitated fish bathes and swims therein.

The same thrill of supreme emotional discharge simultaneously electrifies the females; and millions and millions of eggs are de-

posited in the white seminal clouds. The free semen has the effect of a golden fountain of life on these eggs; it completely surrounds them, embraces them, literally drinks them into itself, and in so doing, a tiny sperm-cell invades every egg-cell, fuses with it and makes it complete, now in possession of the essential new creative forces that will let a new being bloom out of it.

A drama without its equal.

Procreation extended to a joint mass act, whose quivering and wild outpourings make the ocean swell and froth. Each individual conjointly swimming in the vital force of millions, and giving and taking at the same general source.

Even so did the naïve imagination once picture creation: that the strength of a God in a high hour of consecration once poured out infinite semen of all living things into the dead barren waste of the ocean. Out of the clouds on high, Brahma threw the golden egg which, fertilized by the grace of God, gave birth to the intoxication of colours that is the veil of life. . . .

But no poet's imagination could divine the grotesqueness, the whole crude raw enormity of such an act, as Nature injects it into the concrete reality of this fish orgy.

Sublime, ridiculous and horrible motives combine here. Upon the silvery tangled mass of these love-mad fish, whose strength pours down in incessant streams like a cloud-burst, upon these millions of flashing, quivering bodies, voluptuously wagging tail-fins and big motionless eyes, rigidly staring as if with anxious longing, fall all the plagues of Egypt. They who singly are light as feathers in their movements and can slip away into the deep, the veritable tight-rope walkers of their element, are now tightly wedged together in the wild tempest of love. And danger is at hand. Wild robbers draw near to the big love island in shoals, already lured from afar by the bright glow that shines in the fog like a self-lighted nuptial torch.

For them, this tangled nuptial coil, miles long, is nothing more nor less than a gigantic, eminently desirable store-room crammed with living meat. Fountains of steam, several yards high, gush out of the water with a dull roar that resounds afar, as if geysers boiled up out of the hidden chasms: the giant fin-whale is coming, breathing heavily so that the long retained air turns to steam and tears up water along with it; a colossus at times twenty-eight yards long.

It just opens mechanically its bottomless maw and as the wild waters pour in, hundreds of love-smitten fish are carried along with it; and these, the enormous fleshy tongue then slowly rubs to pieces against the hard gums of its toothless mouth, till they're nicely prepared for being swallowed. The fin-whale is followed by smaller sea-mammals, the frolicsome dolphin and the seal. Then comes a no less destructive army of true fish such as haddock, cod, codlings, and the shark, whose frightful jaws crush the soft herring like butter. And from above, out of the fog clouds of twilight, feathered swarms of murderous sea-gulls, auks and guillemots join in the incessant attack and with hard beaks tear piece after piece out of the living silver mass, like greedy treasure hunters at a suddenly bared vein of ore.

And, finally, man, the most dangerous hunter of all, arrives. One boat after another rows through the fog; the herring fishermen with their nets. Boldly they break into the thick of the nuptial swarm. Wedged in the compact throng and upheld by the pressure of millions of fish, the boats, for moments at a time, rise above the level of the sea. An oar, thrust into the mass of fish, is wrenched away and held upright awhile as it is carried off by the compact procession. The nets get covered with thick, cloggy slime, the seminal fluid. They nearly break under the weight of the fish. In vain is every attempt of the defenceless creatures to disarm the enemy by sheer force of numbers. In the midst of all their sensual pleasure, the herring are shovelled from the surface of the water into the boats. Then the nets confine whole parts of the shoal in narrow arms of the fjord, where they are trapped in hecatombs of certain death.

Thus torn apart on all sides, the silver island finally disappears. As if the Last Judgment suddenly descended upon these millions of individuals rejoicing in love. But the great dark purpose is fulfilled. From the fertilized eggs, ignored by all the assailants, a host of little fish will come into existence and, in turn, will wander from the shore out to the high sea. There, they, too, in the fulness of maturity will be seized by the yearning which impels them shoreward into love and sacrificial death. And then a new radiant and silver isle of love will arise out of the black deep. . . .

This bridal procession, likewise, has been repeated since time immemorial. The fish, too, is much, much older than man. In its glassy eye there is the look of the primordial world when the

earth's garden was still uninhabited by man. More than that, man was not even possible without the fish. Fish had to exist before man could develop. Go back millions and millions of years and man is a fish, a primordial fish of an extinct age, possessing only the potentiality of some day becoming a man.

To-day, in the bright light of the twentieth century, nineteen centuries after the birth of the great Reformer, behind whom the history of mankind extends way back to the blood-stained mists of the first beginnings, man and woman find each other drawn together by love-yearning. Out of the passionate thrills of their consummated love a child grows up in the woman's body. And after an interim of the many thousands of years since man first appeared on earth, after so many spiritual transformations, from dawning comprehension to the radiant fulfilment of civilization, a great, significant mystery manifests itself in the embryo that is just germinating, deep in the mother's womb. The embryo becomes a fish again, before it becomes man. In the dark maternal depths, where there is neither land nor sea, the gill-slits appear on the neck of the tiny delicate bud of the future man, the gill-slits by means of which the fish ingeniously separates the vital oxygen from it native element, water. The limbs, too, appear in the rounded form of fins. Once more the picture of the primordial fish arises, quivering in the haze; the primordial fish which, in the grey twilight of a passed age gave life to higher beings, who rose ever higher and higher, until at last man, like a new super-world, flamed out of their crown; man who carries all the sorrows and all the joys of living creatures on his shoulders. . . .

Thus this wild, grotesque picture is connected also most intimately with you.

Again you stand a belated dreamer on a granite cliff and think and think. And out of this welter of jostling fish emerges the self-same dark questions. Wherefore? What is love?

As the voice of Jehovah once cried to Job: "Gird up now thy loins like a man; for I will demand of thee, and answer thou me," so you now call out to love in this phantomlike revelation.

Answer! The sea, the primordial grey sea in which whole worlds are engulfed, gurgles and murmurs and again swallows its millions of love-mad fish. And is silent.

Higher!

You must go still higher to divine what all this means, whither it tends, and whence it came. Gird up your loins; I will lead you.

As at my feet abysses cloven
Rest on abysses deep below;
As thousand severed streams are woven
To foamy floods that plunging go;
As, up by self-impulsion driven,
The tree its weight sustains in air,
To Love, almighty Love, 'tis given
All things to form, and all to bear.

§ 4

Upward! A third picture. A picture that rises, serene and great, out of the coronation flame of all things terrestrial. You are looking into one of those serene holy shrines of humanity, where dwells the reflected light of a cosmic moment. One of those moments, when an individual achieved the marvel of realizing within himself the spirit of long centuries of wrestling humanity. Through the crystal of the lofty window comes the deep golden light of a clear autumn day. It melts in delicate waves like a halo over Raphael's Sistine Madonna.

The word "shrine" is too weak. It is derived from that range of ideas in which the highest is conceived of merely as a loophole in the gay world of reality, a loophole opening onto boundless darkness through which the eye goes blind seeking to discover the pale phantom stars of an extra-mundane revelation.

The great masters of the renaissance did not paint loopholes. When Raphael fashioned his loving universal mother holding the Child Jesus, in the individual form that still stands before us today, he poured into her everything that humanity had until then experienced about love.

Everything that has come down from the animal, everything that during the thousands of years had led beyond the animal, Raphael, with the power of the supreme artist, poured all this into one moment. But in it resides the pilgrimage of countless generations on earth. Above this pilgrimage rise like standards the names of nations of the great centres of civilization, of ideas. The wondrous eyes of this Child are no loopholes. They do not peer from reality into eternal darkness. But there is something in them of revery sweeping through endless spaces and infinite periods of time, a reminiscent dream of all humanity which the magic art of the painter had, at a moment, expressed in the individual.

In the essentials of her figure this Madonna is a woman. Undoubtedly Raphael knew women just like her, which the beholder would have recognized as his earthly model. These most intimate relations are lost. With the death of the individual, Raphael, whose

skull sleeps in the rotunda of pagan gods in the Roman pantheon, the all too personal element (perhaps the shadow of strong, wild girls breathing love, who may have disturbed the ascetic believer in his devotion to the Madonna) has been conjured away into the great oblivion, with so many other rose-garlanded loves of mankind, which must feel a kinship with the fate of the day-fly with its two brief hours of love. But when all personal relations die, one thing remains, Woman.

Man appears, torn into the duality of sexes, man and woman. This was not first achieved in the development between gorilla and Raphael. The two sexes existed when the process of higher organic evolution began both in the vegetable and animal kingdoms. A deep-seated necessity, about which I shall tell you later, must have been the urge to it. The one-celled organism of the very lowest order, as yet neither animal nor plant, reproduces by division, each part becoming a new individual. But this simple method is abandoned as the organism develops into higher forms. It was already discarded by the majority of plants and animals in the remote past. If the Hindu myth were true, and the first human being had sprung from the rose-coloured lotus flower in the sacred river Ganges, generated by the fervent kiss of God's golden eye, he would already have had to inherit the duality of sex from this flower. The water-lily, it is true, still has both sex organs united in one blossom, but the female stigma must be fertilized with pollen from another calyx, so that here, too, true procreation already necessitates a double life, the forces of two separate individuals.

In reality, man is no child of the plant, however beautiful the legend may sound. Man has grown up out of the animal. Even that simplest form of dual sex love, as represented in the lotus flower, was abandoned at a very early stage in the evolution of the higher animals. Among the vertebrates, we find that even the fish abandoned it in favour of absolute separation into male and female, each embodying only its own sex half, with male or female organ with male or female emotions. From the fish upward there is no relapse from this fixed principle. The amphibian inherited it from the fish, the reptile from the amphibian, the mammal from the reptile. In the rising scale of mammals, the ape transmitted dual sex to man. Man appears in history as male and female. Like the man of the lotus flower, the creation of Adam before Eve is a pretty piece of fiction. The real primitive man, who hunted the mammoth,

the cave bear and the giant sloth, from the very first day embraced his female in the cave or sand-pit that served as his retreat.

The symbolically sublime female, as painted by Raphael, carries a child in her arms. In viewing the purely human figure, which the master gives us in its most perfect form, you must not think immediately of the religious mystery with which the dogma of a certain wave of Christianity surrounded the origin of this particular child and thereby completely removed him from the human sphere. The simple eye untouched by these problems, sees only the mother wonderfully transfigured. There merely happens to be something in the mystery of the "immaculate conception" that enabled the painter, so softly, so subtly as to be almost imperceptible, to mingle the type of mother, the perfect female, with the most tender charm of spotless virginity. The Virgin Mary of the picture, considered as a human being, thereby becomes richer than an ordinary mother . . . into this one figure is crowded an entire sequence, as it were: the whole history of woman as individual.

Through the caressing blue of her gown, the eye divines the body that bore the child. The white scarf over the red bodice modestly conceals the breast that suckled him. All these acts of closest, tenderest connection of mother and child, considered from the purely human viewpoint, this act most intimately connecting mother and child, does not point to anything super-worldly. Like dual sexuality, it points to something within man, yet beyond him and before him, back to the animal from which he emerged. Only here the beginnings are not so remote. What does the lotus flower know of mother-love? Its fruit flies over the water, seeks a place of abode and luxuriates there as a strange plant. What does the day-fly know of mother-love? It dies almost in the very moment of becoming a mother. . . . Only the vertebrates in the highest stage of evolution steadfastly press forward to a fixed goal. From the luminous colours of the Madonna, your eye wanders far out into the wild swampy thicket of Australia. There in security dwells the duckbill, the lowest of all mammals; to-day it is still a copy of the first mammal on earth. The duckbill still lays eggs like a reptile; it still lacks entirely the close linking together of the human infant and the maternal organism in the womb. But one of the two surviving kinds of these duckbills already carries the egg around with it in a soft pouch of skin, and when finally the offspring is hatched, it licks milk out of a gland of the mother's

body. This is the prototype of the mother in the human sense. From here upward we have figure after figure: mammals that no longer lay eggs, that carry the young in the mother's womb where they remain for a long while fed internally, by the finest nutritive extract which the blood conveys from the mother's arteries into the arteries of the unborn fruit. After birth they still draw nourishment from the mother's breasts. Even this man received in its complete form from the ape.

And yet, as your thought, that sank from the radiant glory of the Sistine Madonna down to the duckbill, arrives at man again, it seems as if a great veil were suddenly torn asunder, which hitherto had lumped man and animal together in pictures of hoary antiquity.

The concept of mother passed on from the animal up, through the entire chain of demonic figures from the grotesque duckbill to the orang-outang and gorilla, flames up with an entirely new light as it enters the history of mankind. It is the clear light of nature, revealing itself to civilization.

After æons of nature follow millenniums of evolution of human culture.

That being the case, what emanates from animals no longer can be handed on simply as the eternal animal heritage.

Raphael's Madonna, for all its beauty of body, still portrays the primeval organic principle of sexual duality, and with the child that indicates the mother, at the same time floats as if in a higher, a super-world, the product of a lofty spirit.

So. likewise, did love wander upward in the history of mankind, as a figure of light, becoming ever more emancipated, and under which the animal nature, the brute weight of the carnal character, sank and sank.

Man became human.

An upper story was reared within him resting upon his animalism as on a granite block, which henceforth was to serve only as crude foundation to the superstructure.

Now it towers like a temple, whose marble white pierces the glorified blue.

There are no adequate images which serve as real comparison with it. In the abundance of nature's forms, from the distant greenish twinkling nebula to the hard yellow lichen on earthly granite mountains there exists to the best of our knowledge but one humanity. Whether, on other plants shining over us, some-

thing similar has been built up under the spell of the same forces, on this point scientific lore is silent, and speculation hardly dares to venture there. Like an endless bleak desert waste, our ignorance extends in all directions around our living planet into stellar space and creates for us, in any event, a complete isolation in the face of which all comparisons fail.

But right before our eyes is evidence how mankind, unique and unparallelled on this its planet has changed all human concepts. Also the concept of love.

The concept of love has grown out of itself and beyond itself. In the highest sense, the sense which the Madonna seeks to symbolize, it is of such grandeur that compared to it the animal's love is like the simple bed of twigs which the red-haired orang-outang prepares in the jungles of Borneo compared with the parthenon of Phidias or the St. Peter's Dome of Michelangelo, in whose shining structure of light dwell not merely the mortal bodies of individuals but the thoughts of millenniums, detached in a higher life form.

In the Promethean forge of humanity, as the dark ore is smelted in the spiritual flame to new existence, the blind greed and hot passion of simple sexual love became an all-embracing power and longing of a higher, newer, spiritualized kind.

The impulse driving the sexes toward each other, and resolving individuals in the species, evolved in the course of endless change to a longing for a union of all on the basis of ideal love, and developed a power to make such a union possible.

The infinite bliss, the utter forgetting of the world, and pain, and death, in the sexual union of individuals became fused with the longing for a universal harmony, for a universal order leading upward to the light transcending man and his love.

To the power of procreation in the old sense was added the power steeled by the desire for harmony, of a special kind of creation by men themselves, a creation of new spiritual harmonious forms: in stone and colour, in rhythmic speech and chastened sound, man fashioned for himself in the midst of the old Nature a new spiritualized nature of his very own.

Love became love of mankind.

It became a motive power of religious exaltation.

It became art.

All this the Madonna tells you also.

The Child that presses close against the beautiful breast of this

female is no longer merely a simple human child, created by the loving embrace of two human beings in conformity to that old law of Nature followed by the fish and the day-fly in producing their kind. This child is at the same time a symbol of the love of humanity. In this Child, no longer simply a child, love appears as if detached from its original stock, emancipated into a higher existence.

There are low animal forms at the bottom of the sea from the egg of which a polyp springs that is fixed to one place. When it reaches a certain degree of maturity, the crown of this polyp suddenly detaches itself and swims away, free and unhindered, into the wide ocean, a body of fascinating beauty, transparent as an azure glass ball, resembling a golden star at night shining by its own light. Thus it is that love, leaving behind its youthful, immature, original stage, has wandered forth in quest of vastly richer experiences, free and untrammelled. Love wanders, it wanders as a spiritual value in all lands through the whole of Humanity. Instead of aiming at a simple union of sex, it strives for the social union of all mankind, for common work, for common endeavour toward happiness.

When Raphael created this child with the great flaming human eyes—eyes which no child ever had, eyes which are possible only when the awakening eye of humanity symbolically unfolds like a huge blossom—when Raphael created this child, he thought of a definite process in the history of mankind. His look swept backward more than fifteen centuries. It alighted at the eastern corner of the Mediterranean Sea, where a little narrow strip of land is wedged in between the sea and the desert. It is the sea across which the Phœnicians once carried the gold of civilization to the west; the desert across the white floor of which, at the dawn of all tradition, the first civilized races rose up from the east like silhouettes from the unknown.

And as Raphael's gaze rested upon the land, he beheld a hill covered with green palms overlooking the glistening blue sea. On the hill a solitary thinker from the depths of his heart proclaimed to the timorous throng the awakening of human love. Thenceforth the word was in the land and could no longer die. True, the concept was old even then. It was not born in one hour, and it did not come from the mouth of one individual. At least one thousand years before Christ, the whole world in all its inmost parts was pregnant

with this idea. But now it suddenly blazed up and fired the nations, like one of those mysterious petroleum wells, the so-called eternal fires of Baku, which for æons may have been invisibly ascending from the ground as gas until the hand of a single individual, perhaps a child, threw a spark and thus started a conflagration that may likewise burn for æons.

To the age of Jesus the word, the momentary igniting spark that sent blazing up this unparallelled, dazzling light, seemed so overwhelmingly great that the earth, it was thought, was too small to contain it.

The natural course of things must needs be upset. The lightning of human love, it was said, quivered from another world heretofore unknown, a dark cloud beyond everything earthly, outside all human evolution. Under the dread of a thing so awe-inspiring, love was severed from love. Human love must have no portion in sexual love. It must be no sprout, but a meteor falling upon the seeds of earthly love, alien to it, in fact, destructive of it.

This interpretation was still almost all-powerful in Raphael's time. To-day it is strong only because of tradition. To us the wonders of reality, the wonders of natural evolution are so great that they can comprehend so tremendous a phenomenon as the proclamation of human love. It requires no special miracle. When we endeavour to see in love nothing but a growth conformable to law and necessary in human evolution, we feel all the more the thrills that pass through us when we behold sublimity.

In fact, only when we view it in this way does the picture assume such huge dimensions that the eye grows dizzy contemplating it. You look as into a pit in which groups of isolated individuals, of outlived ideas that have dropped away like withered leaves from a tree, flit about like the twittering batlike shades of the Homeric underworld. Not for a moment must we suppose that there is a gulf between love and love. The whole colossal savage substructure of sexual love from the beast upward, from the fish and the day-fly, was necessary for the organic evolution of man's great creation, human love. Without propagation and the evolution connected with propagation, man could not have come into existence. But this does not reveal the narrower sense in which love is one. All union within procreative life, all mutual aid and division of labour, all symbiosis, as the scientist calls it in the lower organisms (symbiosis means living together in collective production)—all these

things, which are found on the lowest plane of life, must in their original form doubtless have had still closer connection with blood-kinship, hence with propagation. While propagation was the very agent producing separations and divisions through successive generations, it also brought about a permanent inner union. Its method of producing new individual organisms was not by letting them drop from the sky through a miracle, but by deriving them from already existing organisms, just as a flame can be kindled only by another flame. Thus it preserved something common to all, which, despite separation and division, frequently led to subsequent union. The oldest protective associations among animals and plants were doubtless always very close tribal associations, close federations of immediate blood relations. We will return to this subject again. Even later, when association grew more complex, when beings with no blood-tie federated, the tendency was still very powerful to attain union through propagation, if not immediately, then in the course of time. As reproductive life itself developed, the tendency in that direction grew stronger. It produced the contrast between man and woman, the contrast that became the imperious cause of the passionate seeking of man and woman for each other, the burning desire for union between them. It produced the relation between mother and child, at first merely the result of sexual love. This relation then gave rise to marriage, which is found even among animals. Sexual love was perpetually at work as an agent to bring together the wild, isolated individuals harassed by the struggle for food, to tame them, to make them live in peace with one another, and help one another. Finally, a point was reached in the ascending scale of evolution when every higher type of animal was from the first day of its existence intertwined and interwoven in an inescapable net of common ties, of tribal and family relationships. With such a net and in such a net, man, too, is born—man and woman, mother and child, marriage and family, defensive tribal unions of blood relations—all this the work of the original crude hand of consanguineous, sexual love. Among men also for long, long thousands of years blood streamed up and closed the net again and again, the hot blood that streams up and is warmed from the sexual organs.

Slowly, very slowly, all this changed into spirit in man.

How the blood became spirit, that is the great decisive secret of humanity's history. It is also the secret of human love.

From real blood kinship sprang up, like the first shy blossom of

the season still pale in the winter sun, the ideal concept of spiritual tribal unity, the concept of the holiness and inviolability of the individual of the tribe regardless of sexual desires.

A huge stride had to be made before this concept was transferred to a people not directly related by blood, to a whole nation in whose veins the same blood flowed—if at all—only in the remote mythical past. But the spiritual force made its way, and the spiritual concept that created the "nation" became the bridge that led from the nation to the community of all civilized men, and finally to the community of men the world over.

As you look upon the ferment of these developments, your eyes seem suddenly to be struck by a flash of light, and you turn your gaze upward.

You thought you were standing at the edge looking down. Now you feel as if you yourself were in the midst of the whirl and part of it. As it came—this play of forces—swirling upward from the depths without end, so it rises above you in bright forms, up into the future, into what can be merely divined, disappearing ever further into a veil of mist.

When human love became a word on that hill of palms by the glistening sea, the word embraced like a golden hoop not merely the fathomless dark work of the past; it also shadowed forth what the work of the coming millenniums was to fashion into truth. The word "human love" already contained everything to which we to-day aspire as the boldest social ideal of the future.

The social ideal! How it comes down to the gruesomely bright reality of our times, heaving, sweating, bleeding! This, too, in the last analysis is but a question of love. It arises from that concatenation of sentiments and emotions which through so many changes always held the word together with steely firmness, link by link. It is the same thing that is latent in the day-fly, which the fire of creativeness rouses from its predatory, recluse existence in the larva state to two hours of careless existence in the bliss of sexual union. It is latent in the fish that sexual love sifts out of the ocean, until like a silvery isle they rise in a mass from the waters, a community of birth-giving sexual creatures for whom the narrow, shallow fjord is one large bridal bed. In man, it is more highly developed and spiritualized, transformed into a new word in the hallowed days of which the Gospels sing; and become a reality only among us, among thousands and millions of crosses rising invisibly to the one cross

that the legend has transfigured into a transparent lily, rising from the dark hells of the modern metropolitan tenements, from the factories where the iron wheel rolls over quivering bodies, from prisons, brothels, mad-houses and poor-houses. And yet it is victorious, it is the sword and the flame of our time, the spark at the farthermost exit from the huge, dark shaft in which we are all panting.

Do you now perceive in what elevated regions you are soaring? Do you hear the call of a new voice mingling with your old questions: "What is love?"

But Raphael wanted to raise you still higher. His Madonna soars up from bright clouds. A universal light seeming to pour from the innermost heart of all things physical and transcending the light of the planets emanates from her. Her foot needs no ground to stand on. She appears to be treading pure space, where all the forces of gravitation hold one another in equilibrium. Raphael's vision was not merely of a woman; nor was it merely of humanity in a woman's form. It was the vision of the Madonna. The face of this woman, of this child, transfigured by love, was his vision of love pulsating to the very heart of the world. Her womb embraced all the secrets of heaven and earth. She is the symbol of the world and the symbol of salvation in one.

A new vast pilgrimage of humanity is opening up before you. In it love wanders like the Wandering Jew. Love became faith, it became religion. At first naked, coarse and wild, it was gradually purified in the quiet filtration from blood to spirit.

Changing pictures pass before your view. There are the sacred groves of Hierapolis. Male organs of procreation of huge dimensions carved in stone rise to the blue of the sky as symbols of the divine power of generation. There is the temple of Astarte, where prostitution is a divine sacrifice and young girls offer themselves in order to gain higher religious purity. Isis becomes the impregnated woman, the woman in labour, the mother of all, whose womb continually begets the world anew. In Eleusis, procreation becomes a mystery, a simple ear of corn, a holy miracle bringing salvation to the faithful.

Then Christ comes into the world. That ideal evolution of simple sexual love which makes for the social side, for salvation through spiritualized work in common and work in love, suddenly grows into a huge power. It appears in a form threatening to destroy the cult

of the extreme sexual, of generation, and of the female. And yet this cult rallies again. The temple of Mary, with its delicate golden stars and chaste blue, grows up out of the sanctuary of Isis, the mother of all, with its garish columns, pervaded by an atmosphere of glowing love and the hot breath of procreation and child-bearing. And again love is the same, except that now it had the softness of the spiritualized ideal. Not only are the wild intoxication of the creators, the blissful pain of the propagators transfigured and glorified. The chastity of the virgin, the first budding love is also raised to the heights of the all-embracing infinite.

Raphael is a product of this conception of the universe. His faith in woman as the heart of the world blended with the other faith, that human love did not arise in man but descended from heaven. To him it was God's child bringing the message of human love from the other world who lay upon the breast of the Madonna standing higher than suns and earths.

To-day this, too, has died away—vinetta bells in the ocean.

Like Astarte, Mary is but a transition form to something still purer. In the time of Goethe we seem to see a new picture gradually fashioning itself from the forms of Astarte and Isis and Mary. Again it is a picture of love raised to the very climax of our conception of the universe.

It is Nature.

We are still struggling with it. Doubt whispers in our ears: "You have built a pyramid of skulls. In nature stripped of God, love will never dwell." And yet, who knows? Here Raphael will no longer guide you; you must step forward by yourself.

The old staunch faith in the loving Father in heaven shrivels up like a little wreath that man has woven from earthly flowers. A puff of wind breaks them and through the rift you again see the distant enigmatic stars of the boundless firmament.

The mystical in the loving Christ has crumbled away. What he taught has become human property painfully acquired in struggle and strife.

But be firm. Nature has given you the idea of evolution. Stars turn into life. And life ascends from form to form up to the intellect, which not only lives evolution, but is conscious of it. In this lies the great consolation; upon this a new optimism is arising.

Now look at the ramifications of this evolution. How it twines and intertwines! Do you not see love everywhere? Upon love de-

pends the succession of generations. Through it the tree of life on the wandering planet mounts from branch to branch, until finally the spiritual blossom bursts forth. Love is an onward-driving force. It has freed itself from its savage state and grown into a spiritualized state. Darkness has turned into light.

The span of evolution that we can survey is extremely small. Life on a single planet and only half of that. A meagre lot. From a few signs we must derive our faith as to the whole, our consolation for the universe. But as far as we know, is not love the strongest of all signs? Not only has love given rise to evolution. With it also the first timid breath of peace entered evolution, the first singing and humming, the first dream-like notes of the overcoming of the rough struggle for existence by a mightier harmonious principle. What do we on this lone, tiny star amongst a million know of universal peace, of universal salvation, of complete universal happiness? And yet, a flower so sweet and beautiful blossoms in the human love of this little star, that the words "universal peace" forcibly rise to our lips. Thus, love invades strife, the bitterest experience of our life.

But more than that. It was the dream of the old faith not only to do away with strife, but also with death. Love alone, the real love, not the mystic and obscure love, teaches us that there are connections that persist beyond the rigid form of the individual, connections from which the individual is slowly severed, loosening like a tightly bound knot, yet not in the bitterness of death, but by merging in a higher, more blissful unity, as man and woman, parents and child, man in humanity, love in spirit, spirit in the ideal, in the overflowing universal space. Love is the only voluntary dissolution of the individual, the painless, ineffably blissful death that every creature seeks with ardent, infinite yearning. Do you see numerous phantom hands rising and pointing to a deep mystery, not a mystery transcending reality but immanent in very tangible nature herself, a mystery which perhaps some day will prove strong enough to make our grandchildren laugh at all fear of death, even though the old faith with its dreams be not restored? To be sure, it seems that in the economy of Nature's evolution, in the very upward progress upon which our optimism is based, there is a brazen demand for the destruction of the individual. Evolution seems to proceed along the very path of destruction. And the soul trembles with the fear of death. But what if love were after all the symbol? Love shows us the only form in which destruction is not terrible, in which it is a

blessed ascent to a higher union. What if death of the individual, too, for all its fearsomeness were nothing but an unrecognized act of love? What if beyond death, after all the bitter struggles, there came at last that perfect happiness, that living dissolution in a higher union which love brings?

Death terminates Life's miseries,
And yet Life shudders at Death's guise;
Life sees the gaunt, dark hand but not
The shining cup it proffers spies.
Thus does a heart shudder at Love
In threatened ruin's wild surmise;
For wheresoever Love awakes,
The Ego, the dark despot, dies.
Friend, let it perish over night,
And freely breathe 'neath morning skies.
RUCKERT (*from the Persian of Rumi about* 1250 A.D.)

To-day you see it only as through a break in the clouds. The new conception of the universe is still in the making. It condenses, consolidates, and casts off rings, like a star in process of formation. Who can tell what bodies will some day circle around it and what will be its sun? But the glimpse we get suffices. The quest of humanity for the world's light reaches out ever farther. And in all the pilgrimages that humanity makes, love accompanies it, wandering along, restless like the old Wandering Jew.

Higher! Spread your wings once again. Raphael's Madonna will sustain you.

Once more embrace her fully with your eyes. See her in her golden frame, her wonderful colours, with her face, in which the feminine beauty of thousands of years seems to concentrate—Raphael's Madonna, who is humanity and the world's mystery.

Whence came this miracle, which the old earth has been carrying round the sun for almost four centuries? Where, in the great cosmic garden, between human eye and double star, did it sprout forth on the genealogical tree of things.

It is art.

From the Madonna your eye passes to a multitude of women equally perfect, some, like the Madonna, painted on canvas with

colours, others fashioned in marble in full outline. The Venus of Milo, with her sound, upright purity, invincible in its joyousness. Michelangelo's *Pieta,* whose gigantic force melts in loving compassion. Titian's naked *Venus* in the Tribuna of Florence, bright as the morning, dreaming of all the sweet things she enjoyed, and enjoying them over again as she dreams. A closely bound union of beings inwardly related rising up here and there in quiet beauty from the swift, changing, onward-rushing flood of the generations of men.

None of these women ever "lived" in the ordinary sense. None was begotten through the bodily act of organic reproduction. And yet there they stand in all their beauty, in our very midst, begotten of an infinite burning love, of the complete self-sacrifice of one individual to another individual, to a "creation," a transference of the highest ideal of one's ego to another, permanent self, which is to survive the death of that ego. They are begotten of the spirit and of the hand warmed to the very finest fibre with this spirit, into the selfsame nature, the selfsame reality into which the child begotten of the sexual embrace is born. And yet they have a special place in nature, not comprehended in the concept of the child and not within the domain of sexual reproduction.

To these pictures and statues are added form after form, an endless train of kings in intellect and power, all quickened to life at the poet's word. Rhythms of language never heard in all the confusion of nature's voices, as if spirits of a superworld were talking. And pure sound exulting and thundering like an eternal solution of all things, like the voice of the innermost cosmic symphony. All this also begotten into reality by a fervent spiritual love, as if the spirit that created human love out of sensual love finally achieved control of the mystery of reproduction for new wonderful purposes.

A great pilgrimage for the third time. Love became art.

Art, too, lies in the path from blood to spirit. Art, too, did not shoot down like a meteor from the sky. The same human being of flesh and blood created it that creates children in the flesh according to the iron law of nature, the human being that is descended from the beast. From the beast he inherited the seed of art. The beast sowed it in the hours of his love.

Do you hear the melodious song of the nightingale? Do you see the butterfly fluttering in its wonderfully coloured dress?

What a way from the nightingale and butterfly upward! And yet it was the way.

Through the æons it led up from nature's deep, dark horn of plenty, full of light, colours, sounds, rhythmical relations of all sorts.

Living beings emerged upon the earth warmed by the heat of the sun. They could see light, they could hear sound. At first dully and faintly. Then the struggle for life, evolution, gave them fixed sense organs, the eye and the ear. The first purpose of these organs was defence. The animal stares anxiously about in the threatening world. It listens for sounds of danger. Danger of attack lurks everywhere. Or it asserts itself; it is the aggressor. Then everything is prey that it can hunt down and tear to pieces with savage greed. Suddenly there came into the life of the individual a factor of quite a different value. Love. The animal looked for another of its kind. Not as an enemy, but with the yearning of love, with the eye of love. The eye of love was the first eye of the ideal. And the power of love was the first to produce "beauty" in the active sense. It painted the butterfly, it gave the bird its wedding dress. It composed the song of the nightingale. Love was the mirror that focussed, at first in externals only, harmony, all the rhythm, and all the unconsciously conceived beauty of living nature.

And then the spirit was added, more and more as time went on. To the seeing eye without was added the creative eye within, the imagination. The human spirit emerged. Man produced no wedding plumage, no gay-coloured wings for his love. He saw all these things with his inner eye as light, harmony, longing and the ideal. He saw it in his imagination. Just as he grew no lion's claws, no armadillo's shell around his body for the purpose of protection, but applied his intellect and saw the weapons in his imagination. Then his hand, which has remained soft and pliable and the pure disciple of his brain, formed these weapons from stone, horn and metal, projected them into reality with independent creative force and founded technology as the germ of all future domination of nature. With the same hand he formed what the imagination saw of rhythmic pictures, pictures of yearning and of beauty. He created conscious art in the highest sense of creation, as the germ of all future extension of nature by men.

This road has now been travelled for thousands of years. Raphael, the Madonna, and so on and on. A new natural kingdom arises, not stars, not an inorganic world, not plants or animals, nor even man himself in the organic sense, but the sounds, forms and manifestations of art. A passionate world pervaded with the hot breath of

love, vibrant with the thrill of savage creation, and yet transfigured, removed, from the earth's sordidness to a pure blue atmosphere of spiritual ether.

A bride's one single kiss
Deserves more in God's eye,
Than all the toil of slaves
That grind until they die.

ANGELUS SILESIUS

That is love developed, love in its upper structure. You must observe it from here, from the golden cupola, to guess what it was in its beginnings. And you must let this gold light radiate back into those beginnings. Hence the dance of the day-fly; hence the grotesque picture of the herring procession. The same natural force is stirring there below in the old primitive waters that is ascending to the sun above from the blue mirror as the purple lotus blossom of civilization. Because it is so, the life of the past cannot be coarse. You too, cannot but regard it as a noble young shoot. Nothing in it is intrinsically small. Light streams back to the day-flies at the brook, the fish in the ocean. You see them as blindly striving primitive souls of love, pioneer dreamers of the great upward struggling spirit of love. This fish, this day-fly—it is Christ, Goethe, Raphael; it is the Gospel, Faust, the Madonna. It is human love, it is the dream of the stars, it is art.

And now come back with me to the very bottom.

Let us begin at the beginning, in so far as there is a beginning.

Let us chat pleasantly, let us look about without haste, wherever the light shines and reveals a piece of root. We know what greatness arises from beginnings. But for the present let us reduce all this greatness to the tiniest possible blue flame in the innermost shaft.

Give me your hand. I must in all seriousness take you down into a shaft, to a wonderful mystery. Gird the loins of your imagination and follow me without fear.

To our hot desire diurnal,
Unrestrained, there is no ending,
Till beholding Love eternal
We soar upward, Life transcending.

West-Eastern Divan

PART II

THE MYSTERY OF THE OVUM-CELL AND THE SPERM-CELL

When the love-night cools and numbs you
And the heart stops beating quicker,
A strange feeling overcomes you
By the silent candle's flicker.

Night's embrace, with shadows throning,
No more holds its fascination;
You are torn by a new longing
On to higher procreation.

GOETHE

§ 1

Whoso an eagle is,
Can swing aloft his pinions,
Outfly the seraphim,
Pierce heavenly dominions.

ANGELUS SILESIUS (1657)

AN artificial light of extraordinary power will serve to illuminate an underworld for us in which but for this light deep darkness is brooding. As the objects suddenly emerge into brightness, they are to appear fabulously magnified.

Your gaze loses itself in a huge shaft. From the background you see a strange thing moving, a great glistening sphere, without light of its own, but made luminous by our artificial day. It is not moving freely, like a star balanced by gravity in open space. It seems to be shoved downward along the shaft. As you look more closely, you see gleaming up from the bottom something resembling ears of a gigantic wheat field glistening in the dew. An elastic ball, our sphere glides slowly along this field, held up by the dew and moved by the soft waves of the sea of wheat.

Being perfectly transparent, the ball, as it thus moves along, affords a view into its internal parts. Its outermost layer, which is rather thick, seems as clear and colourless as the crystal of a watch. The only structure of this envelope that we seem to distinguish consists of narrow canals running straight through the cover of the ball, appearing to form an open connection between the free air around the ball and the inside of it.

The inside, the chief portion of the ball, which is sharply divided from the glass envelope by an interstice, shows a very faint opacity only at the centre. Minute particles, like very fine grains, seem to be swimming about in it, but they are very indistinct. The general impression you get is that the entire hollow space is filled with a more or less elastic, sluggish inland water. At one place, not in the middle, another body is observable floating in the sea of the large ball. This second body is quite distinct and, strangely enough, also has the shape and transparency of a glass ball, though its glass wall

seems much more delicate, scarcely discernible. It may be compared to a dainty little diving-bell equilibrated by water pressure. This diaphanous little ball, like the larger one, reveals, through all the fluid enveloping it, certain details of its interior structure. An extremely fine network or scaffolding delicate as foam spreads through it.

Perhaps our light is still not bright enough. No matter how you strain your eyes, you cannot for the time being discover anything further, whether on or in our mysterious ball. But your interest is growing, for presently you perceive changes going on within. Considering that the substances inside are soft, you are prepared for such changes. But what you see is remarkable in the extreme and indicates that highly mysterious powers are evidently at work in this fermenting structure of the Underworld.

First we are struck by the fact that the supposed network in the little diving-bell is in active motion. It seems to be separating, as we look at it, into loose strands. We think we can count twenty-four strands. But we have no time to pause very long.

All of a sudden a bright little point appears near the bell in the surrounding fluid. Perhaps it was there before, but until now it was not noticeable. It turns out to be, not so much a real body, as rather an eddy in the sea. Though you perceive no actual motion, you get the impression that an invisible little turbine has begun to work in the middle of the water. The effect of its action soon becomes apparent in the form of a little sun radiating rays of water round about. But no sooner have you become aware of this, than you observe two turbines producing a double eddy. This quickly grows more evident.

The two turbine centres, each with its radiating sun, draw apart, and now they actually go through distinct motions. But again how strange! Their suns do not fully detach themselves. On the side where the rays of the whirling suns at first overlapped, a sort of connecting current remains, even when they have moved further apart, as if longer and longer streaks were thrown out in that direction, so that, as the distance between them increases, the pivots should not wholly lose touch with each other in their action. As the field enlarges, the whirling picture finally assumes the form of a spindle. In the middle are parallel wave columns extending from turbine head to turbine head; and from these heads, as the ends of the spindle, the two little suns emit rays on each side.

You have concentrated your attention exclusively upon this play of forces with its rapidly changing phases. Of a sudden you observe that something else, without your having noticed it, has entered the whirl. The bright little diving-bell, which was swimming close by in the same sea, now suddenly grown so turbulent, is all at once drawn into the commotion. Can it be that the turbine rays have struck it directly and stirred it up? In speaking of turbines and eddies I am, of course, only using an image. It may be that in the miraculous scene here enacted powers are at work, radiating and overlapping each other, far finer than the crude comparison with turbines and eddies implies. But that something in this play of forces is now seizing and overpowering the diving-bell is certain.

Suddenly its glass wall breaks and shivers into invisible bits. Its entire contents, the original pieces of that delicate net which seemed to be woven of foam, empty into the open sea, which the turbines are restlessly ploughing. For a while the pieces curl wildly and wind about one another like a torn net quivering in the water. All at once, however, a new order sets in in this play of loose shreds. Though the loose strands are not rewoven into the old net, they seem, under the guidance of a strange power, to be pushed and gathered together into systematic order by a very definite kind of current, each part remaining loose.

Absorbed by this new drama of the bursting and emptying of the diving-bell, we have for a while quite forgotten our free turbines. Now they force themselves upon our attention. We recognize that the turbines, which previously may have produced the bursting of the diving-bell by their wild gyrations, are the restorers of order among the defenceless, tiny parts of the net. In the midst of the general shipwreck the whirling spindle traversed the entire area formerly occupied by the diving-bell. While the pieces of net were wildly curling and serpentining, it assumed such a position that now the suns at its ends emit their rays precisely above and below the place where the wreck occurred, and the great connecting rays of the spindle pass directly across the place of the catastrophe where the pieces of net are quivering. The moment they have the drifting remnants of the catastrophe, the net fragments, within their field, they begin to exercise their force upon them, which arranges them in systematic order. The fragments are driven into the middle of the connecting strand of the spindle and are there jammed up as if at a point of perfect equilibrium. For a moment it seems that the

force waves of the spindle between sun and sun are about to form a new diving-bell, in which the old pieces of net will remain in a new rigid arrangement. The drama seems to have passed the climax. But no. The pieces thus jammed together, and, as it were, rescued now begin a new unexpected performance.

We have paid no attention to their number. Now we are surprised to see that there are so many. We thought we counted only two dozen at first. Now we count carefully and find there are forty-eight. Each of the little strands must have quietly divided into two, each must have reeled off from itself a piece equal to half its length. On nearing the middle of the spindle, these forty-eight arrange themselves prettily, like a regiment of soldiers, into two rows of twenty-four each, one behind the other. But we no sooner perceive this and count the number in a row, when the regiment begins to move of its own accord within the region of the spindle. The two rows separate and move away from each other, one advancing to the under sun, the other to the upper sun. The middle of the spindle becomes empty. What will happen now?

While we are still looking at these things with intense interest, a glance around discloses the fact that in the meantime a change has taken place in the entire structure in the sea. Spindle and suns together with the forty-eight pieces of net under their aegis have slowly floated away from their position in the sea towards the envelope of the ball, which still encompasses the whole. The magic ship with its crew of two regiments at the turbine ends seem to be wanting to land. A moment longer and one end touches the envelope. The upper turbine swimming in advance will soon have to spread its rays flat against the surface. In fact, a sort of wave is seen arching at that point, and a small part of the current is already visibly crowded by the turbine against the surface.

You expect that in the next instant the glass cover will be broken through. But that does not happen. You again observe that this cover and the contents of the ball, which it envelops, are not in immediate contact, but separated by a narrow interstice, into which the wart-like elevation can crowd without bursting the upper envelope.

Will the whole spindle-shaped body press after it and enter the space between? It seems a difficult thing to do and as a matter of fact is not done. The onward march has ceased. All at once the spindle snaps in the middle. Its one half, which, with the advance part at the edge, formed a sort of wave or wart on the main body of

the ball, entirely severs its connection with it. The wart unreels itself loose, as it were, and is finally seen lying as a separate little ball in the narrow interstice between the transparent glass envelope and the main part of the ball. In the wart have entered a part of the substance of the sea, one of the turbine pivots, and one of the rows of twenty-four, which in the meantime have crowded more and more closely against the forward turbine of the little ship, while making for land.

The other half of the spindle, with its turbine and with the other row of twenty-four assembled around it, has divided back into the ball. As it is vehemently rebounding from the violence of the break, it keeps sinking, sinking, without halt until it has reached the middle. But even there it does not come to rest. A new phase of the riddling drama begins.

The half of the spectral little ship left in the waters begins to rebuild itself into a whole. Its remaining pivot doubles. Two turbines are formed and then, as they move away from each other without becoming completely detached, a new spindle. Again this spindle arranges the remaining twenty-four pieces of net in its middle and with them begins a journey towards the surface of the sea. But this time one thing does not happen. The twenty-four fragments of net do not again double into forty-eight. In order to form two parts, they arrange themselves in rows of twelve, one behind the other. Again the slow voyage begins; again the two members separate, as before, to withdraw to the two opposite turbine pivots. But now there are only twelve fragments, not twenty-four, at each and of the little ship. As for the rest, precisely the same thing as before takes place at the surface of the large ball. The wart wave swells, the spindle snaps, its one head slips with its crew of twelve into the interstice under the glass envelope, the other head with its crew of twelve returns to the depths of the sea. Compared with the tiny little balls lying out there on the outskirts, the large ball is still a giant. This time the sinking half of the permanent submarine boat seems to remain at rest. It does not double its turbine, but is apparently bringing it to a complete standstill. In fact, it is forming a new diving-bell round its fragments of net, which immediately weave themselves into a reticulum. The whole seems to have returned to about the position from which it originally started: There is only one exception. The net in itself, without any addition from the outside, cannot furnish more than twelve pieces of the original

size. Even if they double, they can yield only twenty-four, never again forty-eight. There must be a mystery in this. It must have a significance.

In the meantime quiet has been restored in the whole ball. Only the soft beating of the waves on the wet surface of the wheat field upon which it lies still remains outwardly as active as before, driving it incessantly further down the colossal arch of the shaft.

To what world has our fancy carried us? Were we looking into the phantom turmoil of a primeval world, one of those cosmic nebulæ at the beginning of things dreamt of by astronomers? Or were we looking into the convulsions of a planet still not quite cooled, around which a white cloud envelope floats, like bubbling, steaming water, an envelope such as surrounds the colossus of our solar system, Jupiter, whose real globe seems to be the dusky red spot but occasionally seen glowing as through a veil? Are those two little bodies to which we saw the ball give birth, without liberating them entirely, offshoots of a star in labour, like our moon, concerning which there is a suspicion that once upon a time it wrenched loose bodily, like a young shoot, from the great ball of the earth, without being able to escape entirely from the earth's force of attraction, in which it is held captive?

Nothing of the kind.

In our boldest flights of fancy we never left the earth. We remained on its inhabited surface, in the very thick of the welter of humanity. From this humanity we picked out one human female in good health and of mature years. We simply looked into the depths of certain organs of this female body while the body "lived" in its normal condition and while these organs were developing a very remarkable activity. How we managed to do it is immaterial. Perhaps the next century will invent an apparatus for it, which, on the analogy of our Roentgen rays, will suffuse the whole human body with light without disturbing its vital activities, will perhaps project upon a white wall a faithful picture of even the finest internal parts and at the same time vastly magnify those parts and their movements. In the meantime our imagination serves us. It magnified everything for us at will and threw light upon everything.

The mystery that was unfolded before us without seeming to have been brought to a final solution was the process that takes place in and on the human female egg, shortly or immediately, preceding the great act of impregnation by the male semen.

For the process of generation the female of the human species produces eggs just like a hen. The human eggs, however, are not deposited outside the body like those of a hen. The evolution of the new little human being takes place entirely inside the mother, in the "womb." But the human eggs originate in precisely the same way as those of the hen, in a special organ of the female body, the ovary. From childhood on every normally developed woman carries in her body two ovaries, just as she carries two lungs, two kidneys, two brain halves. In these ovaries many thousands of eggs develop, each of which, when matured and fertilized, produces a new human being. For reproduction, fertilization is absolutely essential, and in order to be fertilized (for which a second being, a male, is required) the egg undergoes peculiar processes, the agitated course of which we have just followed with our imagination.

The vault into which we have been transported is, very highly magnified, one of the two so-called oviducts of the female. The oviducts, or Fallopian tubes, connect the ovaries with the larger passage of the uterus.

The ball that moved along in it is the egg itself.

The actual size of the egg is not quite one fifth of a millimeter, hence to the naked eye a barely perceptible point.

The transparent envelope encloses the yolk, or the vitellus, which in the human egg is as strikingly transparent as the envelope. Within the substance of the egg floats the so-called germinal vesicle or nucleus.

We must imagine that the egg has just made its escape from the ovary, where it was previously imbedded like a bud in a special sheath, the so-called Graafian follicle.

It is now on its way from the ovary to the uterus in the intermediate shaft of the oviduct.

The wet ears of wheat, which seem to project into this shaft and sweep our ball downward with their soft wave beat, are in reality the fine hair-like processes, or so-called ciliated cells, which line the walls of all the female organs of generation and by their movements through the oviduct convey to the uterus the escaped egg rushing to impregnation.

In the meantime the egg itself undergoes the last maturing process necessary before the expected impregnation. We have seen what happens. The nucleus of the egg or the germinal vesicle temporarily leaves its place, changes, and by dividing twice helps to pro-

duce the two little bodies between the transparent envelope and the yolk. For the sake of precision I was careful to observe that in our panorama the relations of both size and time were rather arbitrarily chosen. In all probability these processes do not follow each other so rapidly. The expulsion of the two little parts of the body in the egg begins when it is still attached to the ovary in its Graafian follicle, and its final act is synchronous with the beginning of the process of impregnation. Nevertheless, in this, as in all other instances, the time of development no doubt varies greatly in individual cases. We therefore assumed a case with somewhat retarded development, but with a certain excess of speed to make up for the retardation and gain a slight start in advance. Such a case probably gives the most vivid idea of what actually takes place.

The extruded minute bodies are called "polar globules," a name now antiquated and therefore inappropriate. When they were first discovered, their significance was not known. It was evident to the view that when the egg reached its highest degree of maturity, it rid itself of something. It threw out two minute secondary eggs, each of which received a little piece of yolk and a considerable part of nucleus from the general contents. These secondary products as such had no connection whatever with the subsequent development of the child from the egg. Now, was the extrusion of those two little bodies really no more than a removal of waste? Or was it due, perhaps, to a superfluity of force developed in the egg during its short period of waiting before the great act, which made it gambol and sport and lay a few wind-eggs, later playing no rôle in fertilization? Or, finally, was it merely a result of some old tradition, something which once in former stages of evolution, God knows when, had a significance, but which now is utterly useless and merely drags on as an inheritance from the past, just as man still has the ear points, animal muscles which he does not use, or as blind cave animals still often possess the remnants or rudiments of eyes. All these were possibilities so long as we saw merely the first division, the formation of the first wart and the separation of but one half of the spindle. This left the large egg essentially the same as before.

But we cannot pass over so lightly the separation of the second "polar globule," or secondary egg. Here the large egg, that is, the egg that alone undergoes the subsequent development, really loses something of its original capital. At first it had in its germinal vesicle or nucleus a fine network. This net tore into twenty-four parts. The

twenty-four increased by self-division to forty-eight, an act which when taking place in the normal time, is accomplished long before the extrusion of the first globule. "When the egg laid the egg" the first time, twenty-four of those forty-eight pieces were lost. Accordingly, there again remained the original number of twenty-four. Now comes the second division. But this time the number is not doubled. Of the remaining twenty-four parts, twelve are lost. The result is that the germinal vesicle, the nucleus of the egg, has, at the conclusion of this last act, half of what it had in the beginning.

Of late biologists have been devoting very careful study to these pieces of net. They have arrived at the conclusion that of all the contents and capital of the egg they are probably, in fact, almost certainly, the greatest and most important treasure.

In observing the processes that take place in an egg under a microscope the scientist to-day frequently applies certain colouring matters by means of which important parts in the transparent mass are rendered more visible. Since these pieces of net stain readily and thus are especially conspicuous, they were given the name of chromatin filaments or chromosomes. The name has nothing to do with the point I wish to make. The fact of cardinal importance is, that in all probability the chromosomes are the only agents of hereditary transmission in the eggs.

All the "hereditary characters" that the female egg inherited from its parents and ancestors, from all the human beings and animals from which it has come down in a direct line of physical descent are contained in the chromosomes, the tiny net threads of its nucleus. The full significance of heredity is a question about which we shall have a good deal to say later. In the meantime your own experience will suffice. Every child has inherited much from its parents, grandparents, etc. Think of the similarities of feature. This egg, too, is a sort of child. It is to become a child, just as the warm living egg of a hen becomes a chick. Somehow and somewhere the hereditary qualities must already be contained in the egg. And the probabilities are that they are contained in the chromosomes, and in the chromosomes only.

But if it is so, then the fact that the egg at first has twenty-four such chromosomes, twenty-four hereditary certificates, so to speak, and at the conclusion of that process has only twelve cannot be immaterial. In the first case, when the first polar globule was formed, our egg gave away, one may say, merely copies or duplicates

of its hereditary portion. But upon the formation of the second globule, it gave away part of the capital itself; it reduced its capital by half. What does that mean? The nucleus of the egg, with its twelve remaining chromosomes, settled down to rest at the conclusion of our little drama. Will it be permanently satisfied "with half its hereditary portion"? Is it really possible that it had a fortune half too much to be able to squander it so lightly? It seems very improbable. Or is something to follow, something else to happen? Perhaps the egg expects a stranger to help it, a partner, who will reimburse it from his own capital?

Exactly. What we witnessed was only the first act.

Let us return from the dry province of explanations to the actualities of the things themselves.

The egg has in the meantime approached the narrow cleft of the oviduct leading into the uterus. Now comes a highly dramatic and absorbing second act, the act of impregnation.

Our great ball is floating quite in the foreground of the colossal shaft. At this moment strange guests of a peculiar shape are approaching it.

Compared with the ball they are dwarfs. But to make up for their size, they advance in imposing numbers, with extremely animated movements. At first glance it might be supposed that an army of the ghosts of tadpoles were advancing. There is a thick head, to which a rather long tail is almost directly joined. If we look more closely, we find that the supposed head is simply a longish disc, sharp in front. Seen from the side, it is somewhat pear-shaped. No inner organs, or any structure whatever, are at first distinguishable. With this disc, evidently the principal part of the little monster, is connected the apparent tail, somewhat thick at the base, but abruptly tapering down to a very thin delicate stalk, which runs along for some length and terminates in a still finer filament.

All of them are coming from the same direction, but they are a disorganized, irregular squad.

They advance with a hopping motion, the principal part forward, the little tail vibrating behind. Now they are near the great ball, and of a sudden they all seem to be making for the same goal, as if some breath, some fragrance wafted to them from the ball draws them to it, as the voluptuous perfume of the honeysuckle on sultry summer evenings attracts the butterflies.

They throng around the ball. Now that they are in close proximity to it, we can clearly see how small they are by contrast. The narrow canals in the taut glass roof of the ball, which we observed at the beginning, give the caudate arrivals room enough to penetrate to the inside. That is apparently what they are striving for. Immediately several at the same time stretch out lengthwise in the canals, and creep like dachshunds into the pot. There seems to be a race as to who shall first reach the inner space between the envelope and the soft contents of the ball, the interstice in which the polar globules were deposited.

One of the robbers has got ahead. Suddenly, we see him working his little head out of the canal into the open interstice, and the contents of the ball are again set in commotion, strangely astir with life.

Some suddenly awakened sense seems to announce the nearness of the first bold intruder. Precisely opposite the point where it stretches its little head out of the canal, the substance in the ball, as if to meet it, bulges out in a hill-like elevation into the free space of the interstice. A moment afterwards, and the head of the strange being seizes the hand that was extended to it, and sinks straight into the elevation of the soft substance. As if glad of it, the substance embraces it tightly on all sides, never to let it go again.

In vain do the other, somewhat belated robbers crawling through the canals await a similar reception. The ball stretches no inner hand out to them. On the contrary, scarcely has the first fortunate guest plunged its entire head in, when instantly the whole substance covers itself over with a hard dividing envelope, which thenceforth absolutely prevents every intrusion into its soft body. Those who remain outside of the new sheath must, after waiting hopelessly in the ante-chamber, finally perish like wretches.

On the other hand, the bold victor, the first intruder, seems to be having an extremely good time of it inside. For a short while his little tail wiggles about the spot where his head has sunk, then it seems to separate from the rest of the body, as if superfluous. Now everything that follows is apparently the exclusive work of the head within. And very intensive work it is that the head is doing inside.

We can distinctly see in the bright illuminated mass how the small but energetic guest, sinking deeper and deeper, digs up and churns the substance with its tiny body and granule glistening in various hues. But it does not stop with stirring things up at random. You recognize something that you observed before. The little stranger

also carries on his submarine boat one of those mysterious turbines with which we have become familiar in the nucleus of the egg, his apparent tail, that is, the short, thick part connecting the head with the real, extremely delicate, tail having been transformed into a turbine. At first it sits behind the head like the screw of a ship; then the boat turns around on its axis and sends the turbine in advance.

The presence of such a turbine evidently signifies new life in the economy of the ball; for the old nucleus of the ovum seems to have ceased its turbine activities since its last attempt at landing. It lies quietly at anchor in the middle of the sea, as if it never had possessed a turbine. But apparently the strange invader does possess one all the more effective. Behold! It is already surrounded by an entire sun, again a sun of waves driven in all directions of the wind.

And strange to say, it is not only the turbine itself that suddenly gives the strange little boat a growing similarity with the old nucleus of the egg. When the odd thing with its wiggling little tail was forcing its way through the canal, it resembled anything but the nucleus. Now, however, that we see nothing but its head, a tiny bubble, working itself through the sea, the turbine in front, the comparison is irresistible. I will arrange my light so that it falls somewhat more directly upon the bubble, so that, minute though it is, you may get an idea of what its interior is like. See how the similarity grows. There is the same delicate net woven as of foam, that significant net which in the nucleus of the ovum turned into chromosomes, the chromosomes that contain the transmitted hereditary characters. No doubt, this intruder has also brought with it such hereditary material, such chromosomes.

While we examined it with this in view, it advanced quite a distance, and it is evident that it is making its way straight to the nucleus of the egg. The farthest wave rays of its turbine sun throw themselves toward the region where the nucleus of the egg until now has remained perfectly motionless, like a sunken ship. Scarcely, however, has the turbine sun swept its waves towards it, when the old ship begins to stir anew. What sort of a force can it be that has streamed into it with those turbine rays? Is it the force of real waves, or something infinitely finer, electricity, or an attractive and guiding force still wholly unknown to us? At any rate, under its influence the nucleus of the ovum immediately begins to move from its place. Slowly it begins to stir to meet its magic visitor. It is a

solemn moment. In the pale ocean one ball advances to the other. But a tiny interval, and the space between them is traversed. The two have met.

The old nucleus behaves as if it literally wanted to embrace its guest. It sends forth finger-like processes, which hug the little stranger; it clasps its friend to it, rounds itself in at the place of contact. Suddenly the picture of the two balls disappears, they have fused in one another, they have become one. The radiant sun that the intruder has brought with him stands in a full corona around the newly formed central ball, which they now hold in common. Again the great ball has but one ball within it, one "nucleus" floating at the exact centre.

At the very instant the two nuclei united, the delicate nets of both tore simultaneously. In the midst of the catastrophe of coalescing, they segregated into their chromatin elements in precisely the same fashion as in the catastrophe of the egg nucleus. On breaking up, the nucleus of the egg consistently contributed its twelve genuine chromosomes; it had no more left. Strangely enough, the moment the segregation occurred, it became evident that the intruder's net also contained the same amount of material, no more, no less. It, too, on bursting and fusing, contributed precisely twelve chromosomes. Now, when these two-times twelve chromosomes fall into the same pot in the united mass of the two balls and coalesce into one body, the entire capital of hereditary material is again restored. The fused body, the new nucleus of the ball, again has the full number of twenty-four chromosomes.

Thus, we have the old situation back again, except that now half of the restored number does not come from the original nucleus, but is material derived from an alien nucleus, which has penetrated from the outside into the egg.

A few words will suffice to explain the details. The process you witnessed took place hard by the mouth of the oviduct opening into the uterus, hence immediately in front of the organ in which, later, the child remains and matures until birth.

The possessor of the uterus entered into relations with another human being directly before, or not very long before, the drama was enacted. The other human being has certain organs corresponding to the ovaries of the female, which produce large numbers of the little tadpole-like bodies you saw entering as strangers from the

uterus into the shaft containing the egg. These little bodies, microscopically small, but intensely active, are called spermatic filaments or spermatozoa, spermatozoa being a name derived from the Greek, which means "seed animals." They are not, however, "animals" of a special kind, but liberated products or pieces of the living body of the male, just as the eggs in the ovary are products of the female body. In external form they are originally somewhat different from that of the female egg; but that is not surprising, since they come from the male, whose body in general differs markedly from that of the female, though they both belong to the species "Homo." A close examination, however, shows that their inner structure is essentially the same in every respect. The round "little head" of the spermatozoon corresponds to the nucleus of the female egg, the "little tail" to the substance of the egg in which the nucleus floats. Even the point at which the action of the turbine begins is, as has already been mentioned, contained in the thicker part of the tail directly behind the head. This little nucleus head has its net, which divides into chromosomes, just as the nucleus of the egg. The general similarity of the two in this respect originally went so far that the spermatozoon could form twenty-four chromosomes, as the egg did in its first stage. It therefore contained the same amount of hereditary material as the egg. The spermatozoon, too, derived its hereditary capital from parents, grandparents, and so on, including all the relatives that preceded it and were directly related by blood to the individual that gave it birth. But, of course, inasmuch as a different human individual produced this spermatozoon from the one that produced the egg-cell, its hereditary human capital has something individual about it, which differentiates it somewhat from that of the egg. Before our spermatozoon appeared in the body of the female it had undergone a process quite similar to that of the egg. It, too, had thrown out half its hereditary portion in the form of twelve of its chromosomes (by a process of division, which, though slightly more complicated in detail, is the same in principle), so that it might bring to the female egg only as many chromatin elements as were lacking to restore the old capital to its original size.

How this completing process was accomplished, you have seen. The little tail of the spermatozoon simply merged in the contents of the large egg immediately after its lucky entrance. The turbine then drove the head of the spermatozoon and the nucleus of the egg together. The twelve chromosomes in each body were added to each

other, and the original number of twenty-four was thus restored in the new fused nucleus.

It must be understood, however, that now the hereditary material is the result of a mixture of two different human beings, a male and a female.

You know the external act by which the male sperm is conveyed to the female egg. Communication with the outer world of the uterus, at whose inner door the egg is waiting, is provided for by another exit leading to the outside. Once thrown into this exit, the spermatozoa actually work their way by their own movements to the uterus and still further inside.

There, if all conditions are favourable, they come upon the female egg-cell, either already matured or about to be matured.

One of the spermatozoa penetrates to the very yolk of the egg. When the nucleus of the egg fuses with the head of the spermatazoon, the act of fertilization is accomplished, that act from which nine months afterwards, in a strictly legal sense, the child issues from the woman's body.

The "how" of the process you have seen in detail. As to the nature of the striking forces that severally come into play in connection therewith, modern science is still completely in the dark.

Parenthetically, one thing more. In your imagination you have seen something that even the most inventive scientists have been unable to observe as an actual occurrence. We know the human egg and we know the human spermatozoon. We know the human chromosomes, and, according to the most recent and most exact count, it is assumed that their fundamental number, which is restored on fertilization, is really twenty-four, as we told in our story. Until a short time ago, their number was thought to be sixteen. The general conditions of the act have been known for some time and, what is exceedingly important, the subsequent development of the little human being out of the fertilized egg. But no one has yet been able to look into oneself and control the extremely delicate details. Nevertheless, one thing we know as positively as if we had actually looked into what goes on within the body. All animals that propagate by sexual fertilization exhibit almost incredible similarity in the processes of maturation and impregnation, from the division of the polar globules to the fusion of the nucleus of the egg with the head of the sperm. Almost in every case the same process is repeated, exactly alike in all externals, and in the essence, in the

scheme of the process, there really does not seem to be the least difference. The number of chromosomes varies in different animals. In certain worms there may be as few as four, in crayfish much more than a hundred. But the ratio of reduction in the ripe nucleus of the spermatozoon and the ripe nucleus of the egg is always mathematically the same, half in the one and half in the other. Thus, the essential factor remains the same. The outer form of the spermatozoa may vary greatly, but the rôle they play is always the same. The duration of the process may differ even more widely. Certain phases of the process may partly vary in the order of their occurrence, taking place successively in some instances and simultaneously in others. But in every case the result yields absolutely the same formula.

It is really no jump, therefore, if from the analogy with animals, in which the process can sometimes be observed very accurately, we draw certain conclusions even as to the details of the process in man and guide our imagination accordingly. Among the animals that afford us the opportunity to study the act of generation directly are the sea-urchins, for example. The sea-urchins are kind enough to produce clear transparent eggs, which can be artificially fertilized with living sea-urchin protozoa under the biologist's microscope outside the mother's body. Another animal upon which we can now call to help us is the round worm. In the round worm you can see everything as clearly as in the sunlight. Recently we have come nearer to discovering the great mystery even in mammals, that is, animals next of kin to man. A biologic investigator, Sobotta, had the good fortune to observe and photograph step by step in the mouse well-nigh the whole process, from the extrusion of the polar globules to the union of the nucleus of the ovum with the spermatozoon. If, in the scenic production that I staged for you, there are some combinations which in certain details are purely imaginary, as of course there are, yet you may be absolutely assured that in all essentials the things you saw are really true of man, in exactly the way you saw them. They are actual facts.

I will not at this point enter into the minutiæ of what happens to the fertilized human egg and how it becomes a complete human being. That is a long and extremely complicated story. The old nucleus of the egg and the new head of the sperm have become one unified thing, a thing which in material composition at least now includes something of two different individuals, a piece of father and

a piece of mother. Next begins a process which makes us think that the whole affair with the little secondary eggs and the polar globules will be repeated. The turbine of the new nucleus is doubled, the two parts of the turbine again take between them in their old spindle-like structure the twenty-four chromosomes, and these chromosomes do what the first chromosomes of the original nucleus of the ovum did. They again uncoil themselves with full force into forty-eight. Of these forty-eight, one part, that is, twenty-four, again pushes to one turbine and the other part to the opposite turbine. But now comes the difference. This time, too, the little turbine boat splits up in the middle, each little part taking a crew of chromosomes on board. But this splitting up does not take place at the surface of the great yolk sea. The entire sea, the whole ball of the egg now divides at the cleft between the turbines. Instead of forming a minute secondary egg, the whole egg thus actually splits into two "eggs," each containing its due number of twenty-four chromosomes. The segmentation continues. The two eggs divide into four "eggs," the four into eight, sixteen, and so forth. The word "eggs" has now evidently lost all meaning. What we are witnessing is the formation of living building stones on the very road between fertilized egg and child. In a certain sense the complete child is but the ordered product of thousands and thousands of such constituent parts, such living building stones, a huge mosaic work put together step by step, but according to a definite law and building plan, namely, upon the basis of the hereditary material in the chromosomes. The building stones are disposed in layers one on top of the other, and from each of these layers definite organs and systems of organs arise. There is a twisting and turning and folding and grouping, as in a veritable witch's cauldron, from which a little human being is to arise. All at once there is a spinal cord, a head, eyes, legs. For a time, the whole thing looks like a little monstrosity with a tail. It might as well become a pig or a hare. Only the thick head soon makes it look suspiciously like "man." The process continues. And presently you have a real diminutive human being, droll, but genuine. It needs but to acquire certain additional size and weight, when suddenly it will tear itself loose from all bodily connections with the mother and be conveyed through the opening of her uterus and finally through the opening of her entire body into the free air outside. Fundamentally, this "birth" only completes what "generation" has begun, the creation of a new human being

capable of living independently, participating in the heritage of both father and mother, but representing, nevertheless, a new "individuality."

One thing more you must note in connection with the whole process. I told you that the female egg and male spermatozoon each represented a living little "piece" detached from the living female or male body. Science describes this somewhat more precisely in its own language by using a word which we shall meet with frequently hereafter. It says that the egg and the spermatozoon each represents a single living "cell" detached from the parent organism.

In order to understand what this means you must familiarize yourself with a biologic fact, which is simple enough, but which has not yet passed into our ordinary conventional education.

Figure to yourself a large house with a number of rooms. The rooms are of very different height and size and very differently furnished. One serves one purpose, another another. There are bedrooms, a dining-room, a kitchen, etc. The rooms, therefore, differ from one another in the highest possible degree, though on the whole they serve the manifold needs of one single large household. Now, if you examine the walls behind the furniture and paper you will always find the same constituent parts of building material, namely, bricks.

Whether the wall be high or low, whether it be that of a parlour or a hall or even a bath-room it invariably consists of the same kind of bricks which, superposed upon each other and firmly held together with cement, constitute the elements of which the entire house is made.

Now look at an animal, say a dog. In its way it, too, is a large complex house. If you look into its body, you will see chambers and passages of all sorts. Here the heart, there the lungs, the stomach, the intestines, in a word, all the organs, each certainly very different in appearance from the other and with most varied functions. The heart pumps the blood, the lungs purify it, the stomach and intestines digest the food, and so forth.

And yet—examine the wall of one of the organs. Cut out a piece of the intestines and put it under a good magnifying glass. You will find something similar to what you found in the wall of the house. The wall of the intestines, of course, does not consist of bricks. It

consists of certain minute parts of building material, which, on a miniature scale, are actually stuck together like tiny bricks, one on top of the other. These trimly make up the entire intestine, just as the bricks make up the massive wall of the house. The most essential difference, apart from their prevailing microscopic size, is that the structural elements of the intestines are not hard stone-like forms, but soft particles of an exceedingly peculiar substance. The intestine is a part, a "room" of the living organism of an animal, in this case, of a dog. It, too, "lives" as long as the dog lives. Now, the life of this dog, as all life upon earth, depends upon a specific natural substance, a most remarkable chemical mixture. Accordingly, each "building brick" of the intestine is a particle of such vital matter. It takes a vast amount of the particles to make up the entire intestine, and its "life" is conditioned by these particles. They not only form the material of which the intestine is composed, but determine what should happen in it, in this respect the intestine being far superior to the brick wall.

Now, take another "room" of the living house called dog, the lungs, for example. Examine a piece of lung under the microscope. In the lungs, the work performed for the general housekeeping of the dog's body is different from the work performed in the intestines. Despite this difference, however, just as in our real house the same bricks make up the walls of the parlour and of the bath-room, so in the dog the living particles of matter which, laid on top of one another, make up the walls of the lungs, are very similar to those in the intestine, in fact, in all essentials are the same. Their function in the lungs, it is true, is not the same as their function in the intestines, but that does not detract from the fundamental fact, that in principle they constitute the real building elements, the bricks, which make up the living organ of the lungs as well as the living organ of the intestines.

And so you can pick the dog to pieces, down to every patch of his skin, every fibre of his muscles, every bit of his brain. You will always find the same fundamental elements, minute particles of living matter lying one on top of the other like bricks and making up the dog's whole body, just as real bricks make up a real house.

A word had to be coined for this; and by common agreement a name was adopted, not very bad, nor yet wholly appropriate. The unit living particles are called "cells"; and a dog in all his organs is said to be built up of millions and millions of such living "cells."

He is a large building, and the bricks of which he is uniformly constructed are each called a "cell." The cells' habits of life, the work they do differ greatly. The cells of the intestines absorb nutritive juices, the cells of the lungs prepare the oxygen necessary for the organism, the cells of the brain feel, think, and arrange the whole of life, like a superintendent, and so on. But the cells themselves, as such, though they differ most widely in their functions and consequently also in their external form, intrinsically remain almost the same and preserve their fundamental character as the uniform bricks of life.

The dog, which we have chosen as an example, is relatively a very highly developed animal. Now, take a lower animal, an earthworm. You will find the same condition there. The worm does not consist of one continuous vital substance. The living matter of which it is composed is also primarily divided into cells, and its body and organs are made up of an innumerable quantity of cells. The worm is smaller than the dog, and its organs are not so complex. It is therefore composed of fewer cells, just as a hut has less bricks than a palace. But that is the one essential difference between them. At the lowest end of the chain of evolution, we find animals consisting of no more than a single cell. They are like single bricks placed on the bare ground, each forming a "house" by itself. On the other hand, if you go to the plants, you will find that there, too, the higher plants are built up of many millions of cells. The olive tree yonder has a whole store of cells in each of its leaves, and think of the number of leaves on that tree shaken by the wind.

But now return to yourself, to man, upwards, still higher than the dog. You, too, have descended from the animal, you are, zoologically speaking, still a genuine animal. Your lungs, your intestines, your brain exhibit the good old structural brick in the neatest fashion. Your body, your organs, your entire self are one single wonderful edifice of millions of tiny cells, just as those of the dog, the earth-worm, and the olive tree.

But we were speaking before in particular of certains organs of ours, the sexual organs of man and woman, organs like all the rest. Whether you take the female ovary, or the intestines, or the lungs, in each case you have an organ. Now, as regular organs, the ovary and the male genital organ are naturally made up of cells. These cells have their own habits, their specific functions, peculiar to themselves and to no other organ in the body. They do not absorb nour-

ishment like the intestines, nor pump blood like the heart. Their task is a most extraordinary one.

Imagine a room in a house with a real brick wall. The room is haunted. Spirits and elves gambol there wildly. From time to time something in the wall stirs, the wall paper gapes, one brick drops out of the wall and falls in the middle of the room. Scarcely has it reached the floor when it begins to crawl. It crawls through the door and finally escapes sheer out of the house. Outside, after passing through all sorts of adventures and after joining another solitary brick belonging to a neighbouring house, it grows up spontaneously into a little house.

This is literally what happens in our two human houses of cells, man and woman. From time to time a single cell detaches itself from the cell wall of the male organ and runs out of the house. It seeks the human house of a female. There, too, a cell has detached itself from its place in the ovary and has also wandered forth for at least a short distance. The two free cells find each other. What happens next, what they do in consequence, you have seen. Egg and spermatozoon are two individual cells that have thus dropped out of their organs. When they find each other in the process of fecundation and fuse, they form a corner-stone, the first structural cell for a new edifice of cells, a new organism, a new human being.

These are the simple facts. The cells must, of course, possess the power of building up, a power which no brick possesses. In this lies the great mystery of life, which the crude image of our brick house cannot elucidate. But no need that it should, since for the present you are merely to familiarize yourself with the story of the "cell" in general in its relation to the act of reproduction. Keep it firmly in mind. We shall return to it a number of times.

The eagle boldly eyes
The sun with vision sure;
And so wilt thou the light,
If but thy heart be pure.

ANGELUS SILESIUS

§ 2

This, then, is the process of reproduction regarded from the modern point of view, the creation of the new human being seen to the core of things as far as science can penetrate to-day.

Turn and twist as you will, when you look upon that little sun, in which the two nuclear cells fuse together in the most intimate embrace, you are in the presence of the centre of the entire problem of life. This is primarily true for man; and, since to our minds all conceptions of nature proceed in endless radii from the one central point of thought, man, it is also true for the entire knowable world.

You can abstract everything from the word "love," the whole blue heaven above, everything that has grown into the spirit, into civilization, into ideal humanity, into religious exaltation, and the artistic dream of harmony. But you cannot abstract the real simple process of generation without killing the concept entirely.

I am well aware that there are many, many people who will be shocked at this statement. In fact, they will consider the whole story I told you awful. Very well. Let them. They are those who never experience any of the profound thrills of philosophic thought, who never strive with the world, saying, "I will not let thee go except thou bless me," and who fail to recognize that this blessing flows from all sides, that before it there is nothing bad, nothing base. This act of reproduction is as charged with philosophy as a cloud is charged with electricity. What is that to them? What do they know about it? The very people that in a discussion of such matters raise the loudest outcries about immorality are as a rule those who in real life look upon the act as a silly joke. They never feel the awful seriousness with which nature has invested it. To them, if not immoral, it is at least a joke to speak of a philosophy of reproduction.

Yet these dullards are alive to the loftiness of the sun glowing across the silver sea. They feel that it sweeps the soul of man into infinity. They are alive to the grandeur of the huge star of flames, upon whose powers the little earth depends, as the tiny white sail out there on the sea depends upon the immense blue waters of the deep

stretching from Europe to Africa. They are alive to the grandeur of the sun, with its dark spots, in each of which many of our earths could be engulfed, with its red protuberances spurting columns of glowing oxygen into the air half a million kilometres high. And yet that other tiny sun which forms about the sperm-cell and the egg-cell—is it not in its way even mightier and more important for you than the flaming sun of the planets? The real sun rises and sets every day. You drink in its power. It maintains the planet under you in its firm course. Perhaps of all things surrounding you it is, next to the earth, the strongest external power that confronts you. But the egg-cell connects you with the inward life of the cosmos, it puts you in the procession of living things. Through it you are connected with the life of the cosmos, not merely as an observer, but as an actor; you become cosmos yourself. This sun does not simply move outside and above you. It crosses your own path and with sacred thrills sometimes passes through you yourself.

With it you touch the secret of all secrets, the problem of life and death.

Our knowledge of the cardinal act of reproduction as "knowledge" has grown enormously. In former centuries the real facts relating to the process were still obscure, almost as dark as the darkness inside the woman's body. Men saw the preliminaries of the act, they saw the awakening of erotic feelings between man and woman in the sunlight, the moonlight and the starry night, those bewitching feelings which during the centuries of human civilization constituted so large a part of man's ideal and, as time went on, came to embrace more and more of it. They saw the storm of the senses (of a wholly primitive nature with everything cultural omitted) impelling the sexes toward each other, up to the climax of the physical union of the sexes. Then the veil dropped. Some months passed, and the "new human being" appeared, seemingly something quite new, an absolutely disconnected picture, throbbing and pulsating, at first as if but an organ under a warm cover in the obscurity of the mother's body; then, amidst the mother's pangs, recalling the pangs of death, suddenly emerging into the light, for which the whole body seemed already fully equipped with apparatus for seeing, breathing, and moving. But what the connection was between act and act remained a dark mystery.

We have now travelled a considerable distance beyond that point.

In 1590, about one hundred years after the discovery of America, the microscope was invented. It was not until 1677 that a Dutch student named Hamm had the courage to put the warm, living semen of the male under the magnifying lenses. Forthwith he beheld the little jumping bodies resembling tadpoles, known as spermatozoa.

The tiniest little drop of seminal fluid under a magnification of about three hundred exhibits a whole little microcosm of curious things. You see the large round cells, which are the discarded parts of the surface of the mucous membrane of the urethra. You see the so-called sperm crystals, dainty symmetrical structures formed according to the general pattern of crystals and constituting the phosphite of a gland secretion, which gives our semen its highly characteristic odour. And then—the most surprising thing of all—you see the spermatozoa, single caudate cells, which propel themselves by automatic movements in exactly the same way as the primitive animal, the infusorian, which remains a single cell throughout its life. The number of male cells swarming in every tiny drop, ready to impregnate the female ovum, is well-nigh incredible. According to a very careful estimate, there are 60,876 spermatozoa to each cubic millimetre of seminal fluid. A single discharge of medium strength, therefore, contains more than two hundred million. Altogether, a man in his creative years could produce about three hundred and forty billion seminal cells.

We do not know at what to marvel most—the stupendous conception that each of these sperm-cells can cause the origin of a new human being; the minuteness of the spermatazoon that must be the carrier of all the hereditary characters from the father to the child; or the appalling extravagance of nature. The number of human beings simultaneously living on earth is estimated to be only fifteen hundred million. Accordingly, every normal male has the capacity to people more than two hundred thousand planets like the earth. Each one of this inconceivable quantity of sperm-cells is barely one twentieth of a millimetre long. A fraction of this length, the head of the male cell, divides into still smaller fractions to make up those twelve chromosomes in which the hereditary capital is embedded. Nevertheless, those twelve minute specks, the details of which not even the highest-power microscope can detect, suffice to transmit everything that a child receives from the whole of its paternal ancestry. You know to what point of spiritual, intellectual, and physical delicacy such hereditary transmission may be

carried, from the noble modelling of the nose to a decisive trait of character or disposition, from the consequences of an infectious disease in some remote ancestor to the transmission of genius, which makes a poet or a musician. Of the "extravagance" in the economy of reproduction, we shall speak later. It would be difficult to find any other phenomenon in which nature reveals its majesty so awfully as in this tiny drop of the male fluid. Milky ways and nebulæ with their milliards of stars are scarcely comparable to it.

Hamm's discovery was confirmed and further elucidated by the first important microscopist of the seventeenth century, Leeuwenhoek. What the spermatozoa were, these early investigators had not the least idea. They thought they were complete tiny human beings. In the eighteenth century, all interest in them ceased. It was thought that they were real infusorians and that their presence in the true germinal fluid was merely accidental. Even in the nineteenth century so great a master of the science of life as Johannes Müller regarded it an open question whether the spermatozoa were "parasitic animals" or "little animated primitive parts" of the reproductive element itself. It was not until the second half of the nineteenth century that the matter was definitely decided.

Regnier de Graaf, Leeuwenhoek's most intimate friend, simultaneously with him, discovered in the female ovary the sacs in which the human egg grows up as in a perule, the follicles which bear his name. He erroneously took them to be the eggs themselves. It was not until very much later, in 1827, that the great investigator, Karl Ernst von Baer, saw the real female egg.

With the establishment of these fundamental facts, the way was paved for the general understanding of the process of reproduction in the modern sense. The grand capital fact, the "fact of all facts" in love, namely, the actual fusing together of the head of the sperm with the nucleus of the egg inside the egg-cell, was observed for the first time by Oskar Hertwig in 1875, on the eggs of a sea-urchin. With this the road was opened.

To us the process that formerly ended the moment the man and the woman separated only begins after the consummation of their union. It is not until after their union that the secret work between the spermatazoon and the egg begins, in the manner we observed, and it is this work that leads to the real determining fact of reproduction. The ultimate birth of the matured child now also appears to us to be but the natural consequence of this most intimate act.

And yet, in its deepest essentials, this infinite extension of our knowledge of the real facts does not affect the heart of a philosophy of creation, which is as old as human philosophy itself.

Through the change of world conceptions of at least four thousand years, it rises up like a great melody, which, once having started certain currents of thought, can never more be silenced. What we repeat of it to-day, because it is still the starting-point of all our wisdom beyond and outside the limits of microscopes and physiological theories, is at bottom as old and grey as the dust of the mummies. The murmur of the waves from the Euphrates, the Nile, the Ganges, and the Ilissus is wafted down to us through the ages. Besides these ideas of remote ages, Christ is an epigone.

This philosophy turns its vision upon the simplest fundamental facts of human life.

Man as an individual finds himself standing in the midst of this life, he feels himself an ego, as living and consciously moving forward in time. His memory sets no limit to the beginning of his existence. Of himself, without indirect aid, he cannot conceive that there ever was a time in which he did not exist, or that there ever will be a time in which he will not exist. But he learns; and, to begin with, he learns two things.

With inexorable fatality life itself brings him face to face with death.

A limited span of time defines the individual. No intellect, however great or small, guards him against the scythe that mows down everywhere. Patroclus lies buried, but one day death forces belief in himself on Thersites, too. You read in the Jobsiad—and it strikes you as a good joke—the great registry of the dead. In impossible rhymes all the heroes of history are introduced, and of each we are told "he, too, died," Cæsar, Alexander, Aristotle, Jack Ketch, the hangman, too, and Professor Jobs, too. It sounds comical. But behind the fun a tragedy is hidden which assumes awful seriousness when we try to figure to ourselves the hecatombs that have fallen, regardless of worth or worthlessness, ideal greatness, or ridiculous insignificance. The individual in his lifetime makes acquaintance with happy, triumphant characters, who have traversed the unknown regions of the earth, who have dived into the shaft of the foreworld, who with eye and mind have soared to the milky ways and the stretches of Sirius. Of what avail is this infinite reach? The generation of these investigators alone on earth, and in a hundred years

a couple of old, very old men, bent and almost, or completely, blind, dragging themselves along miserably, the last remnant upon the desolate planet. Another quarter of a century, and the stillness of the desert, the stillness of the extinct star, which we imagine, in a picture horrible beyond everything, to hold sway on the moon, or which we dream of in the depths of the universe on the icy satellites of ancient, extinguished suns, dark as night.

That is the one sure fact of observation—death.

And now the second. Man learns to know a wonderful act, which shines upon him like an eternal sun from the same reality that causes death to glide like an eternal shadow through all his hopes.

The act of reproduction.

A woman fires his senses. For a moment infinite bliss streams through him. Soon they themselves will be passing whither all the joy and force of living creatures vanish, leaving but a shadowy memory behind, a memory which, with all the other possessions of the individual, will finally sink down into the gulf of death. But from the act between the man and the woman, something quite new arises, independent of their subsequent death, a new human being. The creator is perhaps thirty years old. He may live to be ninety; then death will overcome him. And the new human being he created may also attain to the full age of ninety. In that case he will outlast him thirty years. And if, within the ninety years of his life, he, too, has brought forth children, then there will again be living human beings on earth who will survive his death a certain period of time.

From this simple calculation it is seen that reproduction counteracts death, at least in its total effect.

Instead of being hurled into the eternal abyss of death's first hecatomb of the first generation, humanity, like a tenacious climbing-plant, has for thousands and thousands of years been winding around the little lead in time that each succeeding generation has over the generation that begot it.

As long as man has been able to think at all, he has been facing these primal facts—death and birth. The manlike ape, with the first ray of awakening intelligence under the bestial projections of his eyebrows, may have had a first dull perception of these facts. The rough cave-man, who hunted the mammoth and the rhinoceros, began to reflect and ponder. From then on, the myth stretches into the infinite. But every great, profound sage who, in the pure service of truth, advanced humanity's mind a step higher, returned again

and again to the thoughts of the cave-man as to a lodestone. And the simplest of men understood the sage because of the very simplicity of these fundamental facts. He understood him under the twilight-green canopy upon the black columns of the sacred fig-tree at the Ganges, which shuts off the world like a living temple; he understood him under the starry sky in the rarefied atmosphere on the mountain heights of Peru; he understood him by the endless yellow waters of China; he understood him there where the glowing desert melts away into the iridescent fata morgana.

Reproduction seemed to be the only certain, unequivocal, visible form of immortality in human existence. To it was due the very existence of "humanity" the existence of thought transcending generations, of a continuous line of tradition, of a running thread of the contents of thought.

Man never has complete
Unmarred felicity
Except when Unity
Engulfs Duality.

ANGELUS SILESIUS.

§ 3

Immortality! In the flickering gleam of the word, the centuries of human thought rise up into resounding columns, recalling in more senses than one the old voice of that famous colossus of Memnon in Egypt, about which there were hundreds of conflicting opinions among travellers, and about which we do not know even to-day whether it owes its origin to the deception of priests, to an illusion of the senses, or to a purely mechanical effect, probably the action of the sun.

There are two conceptions of immortality, ideally not exclusive of each other, yet starting from two diverse points of view as different as can be imagined. In the history of thought, these two conceptions are co-extensive with the philosophical knowledge of the simple facts of death and reproduction.

One conception clings to the individual. According to it, the individual is the highest form of existence. Each individual is a world in himself, developed out of the dark and evolving toward the dark, but always progressing and advancing. Such a conception must make the utmost effort to give a completely new interpretation to one of the two fundamental facts of human life. It does not admit death as the end. In this view, death is merely a characteristic stage of evolution in the individual's pilgrimage through a world, a stage of evolution at which he simply disappears from the sphere of vision of those who have not yet reached an equally high stage of development, that is, the living. But he does not perish. The visible period of life with its fifty to a hundred years, or even less, is only a fleeting constellation; the real star of the individual shines beyond the millenniums. It has its hidden sun around which it revolves, revolves more swiftly than a planet around the visible sun of our system. The planet may fall, it may go up in flames, but the immortal individual never. This conception of things has been fighting its way through the thought of humanity with tremendous energy, borne up by all the spite of the individual, who revolts at the idea that the world, a gay kaleidoscope outside, is eternal, but that the I, who seem to be looking down as monarch upon these things whizzing by,

in their flight, am one day to fall from the tree of life like a worthless leaf; borne up by the feeling deep down in men's hearts of the irrationality of the thing, which they refuse to accept. This thought has sprung up in the most wonderfully ideal, as well as in the most commonplace, forms—from Plato, for whom the earthly reality of the individual was but a pale transitory dream, quickly vanishing into a much higher ideal existence outside of time and space, to the great Fechner, who dreamed that there was a psyche extending beyond death, parallel to, and coextensive with, all the mechanical waves that ever issued from an individual and rolled on forever afterwards in the mechanical scheme of the world. But along with these sublime pictures there is also the sorry picture of a schoolhouse, where, at the conclusion of the term, the teacher metes out punishment to the pupils for the things they have been inadequately taught.

Philosophical systems come and go. Every new philosopher is a Samson pulling down the pillars of the house he is in. Church dogmas, which petrify on such systems, are corroded by the storm of ideas, until they are blown away into empty space like fine meteoric dust. You may place what value you please upon things, this is certain, that, as you approach the present, a more and more obscure bank of clouds settles on this field. For our purpose, we can let it lie there as it is. You and I know what a colossal question is buried under it. It is sufficient for us to have mentioned it. We will let the great Sphinx rest here, and we will not inquire whether the sand in which she lies buried rises or sinks.

But the knowledge of the second way of immortality advances with incomparably surer tread to take its place beside the faith in the immortality of the individual. True, this second faith in itself cannot save the individual, but at least it can save humanity. It is the way across reproduction, across love.

In principle this conception is also very, very old. It is so self-evident that it must perforce be old.

Before such simple, logical conclusions two thousand years of human thought, more or less, are in the biblical sense really but as a watch in the night. A father dying blesses his child; there you have the entire thought clearly outlined. The father dies. You may explain this phenomenon by the other conception which has just been described. But the child lives, and the line continues in him. Millions of such lines, crossing one another, intertwining, producing

new lines—and you have humanity. The child will bring forth grandchildren, the grandchildren, great-grandchildren; all upon this earth, under this sun, which gave our oldest forefathers of whom there is any record ground to stand on and warmth and light. Upon the eternal earth, under the eternal sun, is eternal man resting upon the mystery of love, which makes him immortal.

But though this conception is old, it has grown ever younger, and has exhibited greater and greater vitality as it approaches the present. True, it must be taken with a qualification; but this qualification being granted, the cloud seems to lift higher and higher.

Here we must ask one question.

Eternal humanity!

Eternal earth, eternal sun!

In our modern conception is there any room for the absolutely "eternal"?

The ancients looking backward saw but a few centuries of humanity. Their purview did not penetrate even beyond civilization. But the natural scientist of to-day lays his hand upon that piece of brown rock split by the waves. The rock dates back to a time when man was still non-existent. And the whole earth? Is not the earth, too, a mere relative concept to us? A speck of light blown up from the depths of time sparkling, darkening, "living," and blown away again? Is not the "eternal sun" a dream from which we have awakened, since we know that all the fixed stars are suns and that red autumn breaks upon these fixed stars as upon a terrestrial grove of pines, that they are visited by catastrophes, which send them up in flames like a young oak struck by lightning, that the icy space sucks up the glow of their hearts, until they turn rigid with the death of winter?

Surely a new picture unrolls itself before us to-day, quite a new conception of cosmic things, which demands the subjection of the idea of immortality, of eternity, to a process of logical renovation before it may be again used in the old sense.

What the simple, as well as the most refined, thought of older days lacked was a concept now inbred in our flesh and blood, the concept of evolution.

Essentially, this concept is not outside the scope of the word "eternal"; but it sheds over the concrete picture of that sonorous word the charm of infinite change, hence of infinite wealth. It throws into a uniform white mist a streak of light from which a blooming,

breathing landscape arises, where everything is alive with movement. The trees burst into blossom, the mountains stretch, rise up, and cleave, the sea swells and booms. And in the deep blue sky, new stars shine across the changed horizons, as if a wonderful spring has awakened in the cold cosmic all.

In the one "watch in the night" of the history of civilization, humanity has actually been watching. In that watch, thinkers have thought and built, instruments have been invented, libraries collected, and museums and astronomical observatories reared. If today, at the end of the watch, we say that the most evident fact by which man hangs in the "eternal" life of the cosmos is reproduction, love, then the concepts "man" and "cosmos" sum up all the ardent work that was done in that great watch in the night.

We see the cosmos extending not merely into dark eternity, which is a melody, but not a picture, but also into the colossal reaches of real space and time. We see humanity as a whole emerge into a huge, tangibly bright panorama, unfolding itself before our vision in the streak of light in the great mist.

And we perceive a growth within love also. Instead of the simple word "eternal," we are impelled to seek love in the cosmos, slowly growing up from the blue sea of time like a variegated island. That is the specifically new which our time has added to the simple old picture of facts.

This growth, this evolution is the really "Eternal." In it lies the never-to-be-broken connection with the whole past as well as the guarantee of an endless future. Behind humanity is its step-by-step evolution. Even the most remote fate of our planets, the fixed stars, is only the further progress of this evolution.

A column of gold comes flying toward us. Let us venture forth a distance in our little boat, to see how far we can go. Surely navigation with our modern means is better than to embark in quest of the immortality of the individual. Such a quest nowadays is a deceptive Odyssey—fair naked sirens enticing the seafarer and devouring him if he yields to their allurements; Cyclops imprisoning the thinker in their cave, so that he is glad to effect his escape by hanging to the belly of a ram; Circe, the witch, turning philosophers into donkeys; and lotus-eaters gormandizing themselves on sweets into eternal sleep of the mind. Our path is simpler, though not altogether lacking in the element of the fabulous.

It leads through the huge fable of modern natural science.

There is a rainbow in the sky, the rainbow of love. You have seen one end of it. It shines upon the simple act, which you have witnessed, of human reproduction through the spermatozoon and the ovum. Let us now hastily attempt to get to the fundamental point at the other end, where love first enters within the field of vision of the scientific investigator.

§ 4

I am the mote in the sunbeam, I am the orb of day;
And to the mote I say, "tarry!" and to the sun, "dance away!"
I am the shimmer of morning, I am the breath of eve,
I am the leafy grove's rustling, and ocean's murmuring heave.
I am the mast, the rudder, the steersman and the bark,
I am that whereon it shatters, the coral reef in the dark.
I am the flute's soft breathing, I am man's spirit and dream,
I am the spark in the flint rock, and metal's golden gleam.
I am intoxication, the winepress, the grapes and the wine,
I am the tippler, the inn and the goblet crystalline,
The candle and what circles round it, the night-blooming butterfly frail,
The rose and, made drunk by the red rose, the amorous nightingale.

RUCKERT *after Rumi*

To see a thing with the eyes of the modern scientist means to set it in a space in which distances are counted by millions of miles, and in a past in which time is counted by millions of years.

The blue crystal gold-studded bell arching so benignly over ancient man, like the glass roof of a hot-house under which the faithful gardener raised his human fruit, both coarse and fine, is broken into shivers, into a host of isolated glittering specks of cosmic dust. Between the specks of dust stretches the free space, icy cold and without air. And the specks only seem to be specks, because the space between them and us is the realm of millions of miles.

Beyond those millions of miles are gigantic suns, from which the light pours, pours, and pours in huge streams to the farthermost stretches of the universe. This light flows with incredible rapidity; its wavebeats throb through space with a velocity of one hundred and eighty-six thousand miles a second. And yet it requires four entire years for the nearest of those fixed stars to reach our human eyes on the solar planet, the earth. This, the brightest and most magnificent of all the double stars, shines in the southern sky, where

the constellation of Centaur blazes; according to the number of miles light travels per second, those four light years represent several billions of miles, which therefore is the distance of the star from us. And yet it is held to be the nearest of all the myriads of fixed stars in the firmament. There are other stars, from which it takes centuries for the light to reach us.

Their appearance may have changed long ago, and what we see now, when the ray of light that left them has at last reached us, may be vastly different from their actual appearance. And if the faint gleam of our earth is discernible on those stars, then the earth appears as it was decades, centuries ago, without railroads, without the Eiffel Tower, without the Suez Canal, and with the island of Krakatau on the Strait of Sunda before the terrible volcanic explosion of 1883, which blew it up in the air. The distances of other stars probably amount to thousands of light-years, each of which has three thousand and sixty-five days, with twenty-four hours to each day, sixty minutes to each hour, sixty seconds to each minute, each second being equivalent to a distance of one hundred and eighty-six thousand miles. Until recently the genuine nebulæ, wild masses of gas often seeming like the embryos of world systems still in the making, were thought to be removed from us by such vast distances. To-day there is some doubt of this. Possibly these very formless nebulæ are nearer than we imagined. At any rate, there is no doubt that certain groups of stars that the spectroscope definitely reveals as systems of fixed stars but no telescope can resolve into individual stars, must be floating at an inconceivable distance from us. Even the remotest of the fixed stars of which the distances can be measured are so far away from us that the boldest cosmic imagination may well be content.

This is the space into which the scientist throws you, because you and all of us are creatures of this thick ball of earth, which in some unthinkable past was hurled into space, and reached by thousands and thousands of light waves from all the nearer and farther silver worlds has since been flying in its lone elliptical trajectory around the sun according to precisely the same law that a cannon ball follows on the earth's own surface.

No less prodigious is time. When men, the good hot-house product of a gardener's mystical purpose, sat under the secure blue of the heavens, the counting of the time preceding them was still a simple pleasure. Some two thousand years back, and even

the most aristocratic genealogical tree ceased. The welter of nations vanished, and from the boundless blue arose a garden gay with flowers. Adam and Eve kissed; the sacred silence of a world's dawning; except for the stealthy creeping of the serpent, with which all the untold woe of after times crept into the dewy meadow of Eden. A very brief interval, and God threw the earth into space, and the sun into the quivering firmament, with that grand passion of creation which Michelangelo was perhaps the only one of all the believers and unbelievers of the Christian dogmatic era to feel fully, and the only one to give artistic expression to it by creating the picture on the ceiling of the Sistine Chapel.

Science has not overthrown art, she has not overthrown the individual power of imagination that created the immortal picture on the ceiling. With an iron hand it has overthrown the visionary ceiling indwelling in the whole of tradition, which professed to be a true record of history. Back of the few thousand years of humanity that the ancients saw, back of the few days of that mythical fling of creation, it has opened a door into a real infinity —millions of years of strictly historical evolution.

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Assume, loosely speaking, that Cheops of Egypt, from whom the Great Pyramid is named, undoubtedly the work of a splendid and very highly developed civilization, lived about 2,500 B.C., in round figures, almost four thousand five hundred years ago, and some two hundred years before Hammurabi, the great king of united Babylonia. There are inscriptions from the time of Cheops containing records of temples of mythical antiquity that had been buried in the sand and were then rediscovered. The Great Sphinx was already so old that it had to be repaired. As a matter of fact, a highly developed Egyptian civilization had in Cheops' time been in existence at least over a thousand and several hundred years. It is approximately to that period that the old Babylonian civilized world belongs that we connect with the name of King Sargon I. The date of his death about coincides with the Jewish date of the "Creation of the World," which is still given in our calendars. But behind that stretches the old, old, Sumerian civilization in the Euphrates Valley, extending back probably to the year 8,000 B.C. In what a remote age civilization loses itself, a civilization that created works before which you to-day stand wrapt in admiration, with an uncanny thrill at our inability to imitate them.

Thanks to very modern investigation, however, we now know a much simpler and older civilization, which as yet used no metals and in which stone implements were employed to kill gigantic animals, which at the beginning of written tradition had already completely died out. This civilization, proved to have existed in Central Europe by remains that are unmistakable, loses itself in an epoch that geologists designate the ice-age. According to an astronomical calculation, which has much in its favour, the climax of the ice-age (or rather ice-ages, for it covers a period with intervals and repetitions) goes back to at least more than one hundred thousand years before Christ. Nevertheless, skulls of the last stage, or perhaps even of the beginning of that extremely prolonged ice-age, have been found in Europe that are human skulls and not those of the true anthropoid ape, although they are, at least in certain respects, more primitive than the human skulls of the present. We possess from the hand of men of this period pictures of animals painted on the walls of caves in the south of France. These pictures representing the diluvial animals of Europe of that time, mammoths, antelopes, wild horses, etc., are not only easily recognizable, but exhibit a highly characteristic technique.

However, it has been proved on good theoretic grounds that man must have descended from some really apelike forms. It is probable that up to the diluvial age, the epoch of the northern ice-age, there lived on the island of Java an uncanny creature, the famous pithecanthropus, which seems to have combined a skull very much like an ape's with legs extremely elongated like man's legs. But even in strata of the same period, it is said, there are traces of human civilization. Considering the abundance of European diluvial finds, this is not in the least surprising. If in truth there was an "ape-man" wandering about in those primitive forests, he must have been a belated survival in somewhat the same way as the sphenodon still living in New Zealand, a primitive saurian of the Triassic period belonging to the forefathers of the reptiles, is a survival, or as the Australian ornithorhynchus and the mud-fish also very primitive transitional forms. But the actual process of the evolution of man must extend far back into the Tertiary period. It is the long geologic effort before the diluvial ice-age, which must doubtless have lasted several millions of years. We have indications to-day, supported on good evidence, that an extremely simple initial civilization, a civilization, however, presupposing either

fully developed human beings or beings almost human, reaches back as far as the Tertiary epoch, the so-called miocene period. The question is not yet fully decided, but the hypothesis is highly probable, being based upon certain elaborated chips of stone, the so-called eoliths, which thus far have been found chiefly in France. Going upon this hypothesis, the appearance of man must be placed in the oldest Tertiary epoch, the eocene period, that age upon which the scientists bestowed the name of the "dawn" (eos) of the "new age," without as yet having knowledge of these significant facts. Therefore, to set the great date at several million years before the Christian era is not to make a high but a low estimate. In general, the chronogical estimates of geologists are still far too tame, rather than too bold, for all the cheap scorn of the ignorant.

Through the entire first half of that Tertiary epoch, tall palm-trees were still growing in Germany. Forests of magnolia and evergreen oak stretched to the regions of the north polar deserts of ice, now absolutely uninhabitable. The south polar lands, to-day totally glaciated, were covered with green forests of beech. And yet, as the very name tells you, the Tertiary period, comprising the third great epoch in the earth's history, is a late, relatively young epoch. An inconceivable lapse of time divides it from that jurassic period, in which the present Jura Mountains were deposited as horizontal layers of mud at the bottom of the ocean, mud that hardened later, and through the building powers of the earth's crust piled up high above the water into mountains. In the jurassic sea swam the ichthyosaurus, already extinct in the Tertiary period. Thus, we go further and further back to the distant grey dawn of earthly things; to the forests of the carboniferous age, those mysterious forests of fern whose petrified remains we, as practical geologists, burn in our stoves; to the first appearance of organic life in general. That certainly reaches back a hundred million years. And yet the origination of life, too, was but a step, though no doubt a great one, up the endless ladder. Is it possible that previously the earth had been in a state of incandescence? Did it first have to condense out of loose cosmic substance? Was there a primal state of things, when all the planets were one with the sun? Was there a state even more remote, when the sun separated from the cosmic oven of one general system? The boldest sweep of the mind must pause here, no longer able to grasp clearly the values involved, and the boldest chronological figure also fails us, rolling

back into the misty sequence of trillions, into the unfathomable past, as infinite as the unfathomable space in the present cosmic heavens.

"For behold, I will create a new heaven and a new earth." The new heaven and the new earth, which the prophet saw in his vision, have really been granted us to-day. A new space, a new time. In such an environment, all the old conceptions spontaneously assume a new aspect. The tiniest object reflects this truly new cosmos. It is only now that we involuntarily look for the cosmic meaning in everything. This granite block was perhaps present at the seething and boiling of the earth in the primitive days of its evolution. This piece of slate originated when the ichthyosaurus preyed on coral bottoms. This ungainly piece of meteoric iron comes from the depths of space, perhaps having traversed the expanses of Sirius, perhaps a relic of a world that flourished long before all civilization on earth, a world that bore its human beings with all their yearning, and in a moment of horror, now vanished and gone, was shattered into tiny atoms. But the world of stars may be so immense that the light that issued from that particular star-world may still be wandering in siderial space, striking eyes somewhere and presenting its picture as it was in the remote period of its existence.

What new impetus, what new movement a world such as this imparts to the things that concern humanity most profoundly, Love among them! The eye looks for love in the millions of time, the millions of space.

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In the city of Stuttgart, there is a little spot consecrated to the natural scientist. The walls are simple and white, without any ornamentation. In long cases ranged along these walls are dark stone fragments, on which your searching eye will discover certain outlines, more or less resembling broken skeletons of animals. They are slabs of black jurassic slate dug out at the foot of the Swabian Alps. On the slabs are the fossil remains of a large sea reptile with strong fins, huge eyes and a crocodile snout, full of terrible teeth. This monster is the celebrated ichthyosaurus. The stone slabs, which have preserved for you the last remnants of his existence, an existence that once must have been very powerful and imposing, originated in the depths of an ocean as soft masses of mud, at a time when there were as yet no Alps, and when the open

sea of the Mediterranean swept northward as far as Swabia. Since that period a succession of years has elapsed, for which the simple word "million" does not suffice; it must be multiplied a number of times—how many times we will not discuss here.

And yet this shadowy host of primitive ichthyosauri, which once existed upon earth in flesh and blood, tell us of Love.

Between the ribs of an ichthyosaurus you see lying dainty miniature editions of the great mother beast, unborn young, suffocated before birth by some storm and buried in the mud together with the pregnant mother. The ichthyosaurus did not lay eggs; it brought forth its young alive, like our saffron-bellied mountain lizard.

There is no doubt that these young were produced in the regular process of love, just as all the reptiles and the vertebrates are produced to-day, through the bodily mingling of a male-cell and an ovum-cell, through a common act of the male and the female, accompanied, no doubt, by violent amatory transports. The ichthyosauri, at least some of them, were colossal animals, reaching a length of ten metres. When their enormous, vertical tail-fins lashed the waves in an erotic storm, you may imagine it was no namby-pamby spectacle. Perhaps the males waged bitter warfare for the possession of the female, as do our little common lizards on the green slope of a hillock in spring, engaging in a regular duel and never resting until, if possible, one of the two rivals has had his ornamental tail bit off. In the case of the ichthyosauri, to be sure, the combats must have been such that the sea "boiled like a pot," as from the biblical leviathan. Perhaps the happy victor then consummated the wild act of love with the hardly won female after the manner of our whales, who, though not reptiles but mammals, in many respects resemble the ichthyosaurus more than any living or extinct animal. The male and female whale, in some cases giants more than twenty yards long, rise up erect in the water for the act of reproduction and embrace each other with their huge fore-fins. The whale lashes the sea with his tail-fin, so that it roars and boils. The ichthyosauri may also have bellowed like their nearer relatives, the crocodiles. Perhaps over the place of their amorous embrace a cloud of penetrating musk odour arose, such as issues from a crocodile when in a passion.

Thus fancy sees a love idyll separated from us, in very truth, by many millions of years. You will obtain an idea of how remote

it is in time if you reflect that the foaming wave stirred by the passion of the ichthyosaurus in the region of our Swabia, may have broken within sight of the loving pair against the reef of an oceanic coral island, like the coral islands of the Pacific to-day. Over the edge of the corals nodded the great hard tails of the palm ferns or sago palms, such as now grow in the tropics and furnish the palm branches for our funerals; or perhaps the gold leaves of the beautiful gingko-tree, the tree we see in the temple groves of China, a pine bearing wonderful, bright, two-lobed leaves, which served as a poetic symbol of love to Goethe: "Dost thou not feel from my songs that I am one and two——"

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As the ichthyosaurus rose so tangibly before us with its love, so may all the grotesque creatures on the stone slabs, in the glass coffins of our museums arise, all the unspeakably hideous monsters, which from this day backward to the time of the ichthyosaurus swam the sea, flew through the air, and surmounted the earth. We can imagine them all in their love emotions, love acts, and love postures, a phantasmagoria of unchained passion, under which the land quakes, the ocean swells, and the myriad-years-old primitive forest snaps and cracks.

There trots a mammoth pair with red wool through the black yew forest quite near our Berlin, at the present gravel pits of Rixdorf, upon which the bright electric lights illuminating the metropolis in the evening cast their magic blue sheen. They are colossi of the size of the largest elephants, with long trunks that send their shrill ear-splitting trumpet tones through the entire forest. The male is now afire with love. His parotid glands begin to perspire. Thrilling through and through with fearful excitement, he brutally attacks the resisting female. At last his fighting blood subsides. The two now stroke each other's trunks caressingly, until finally the love tempest spends itself in a titanic act, as if two mountains wanted to climb on each other. This is the way the elephant does to-day. Why should not the mammoth have done so then?—except that the white, wildly straggling tusks must have gleamed in the moonlight in the stormy battle of love and twirled hither and thither like four gigantic serpents darting forth from the coarse double clumps of shaggy red hair.

There are two megatheria, the giant sloths of South America, whose haunches were almost three times as thick as those of the

mammoth and whose arms were of such strength that they could tear down large forest trees, sitting on their haunches and tails. Slow in their movements, as they no doubt were, their love outwardly may have been devoid of passion. But when in the stillness of the night, the sexes lured each other from thicket to thicket, their "Ay," the love-cry of the present-day sloths, must have swept the grassy plains, in the holes of which men were already carefully hiding, like the howl of a hurricane.

In the swampy reed-beds of Madagascar the giant bird æpyornis, half a yard taller than the ostrich and with legs much thicker than those of a large ox, lay eggs having the capacity of five ostrich eggs.

The colossochelys, the land-tortoise of India, twenty feet long and rising to a height of eight feet—what hardships and struggles it must have cost husband and wife to consummate the joys of love! Do not our little common tortoises often spend hours in a vain effort so to adjust their stone-hard, shell-encased bodies, the one flat, the other upright behind, as to enable the generative organs to reach each other?

And now the contemporaries of the ichthyosaurus itself, the fabulous long dragons and flying-dragons of the saurian species. There is the iguanodon, whose skeleton has risen again from the coalpits of Belgium and towers two stories high in the museum of Brussels, a reptile which, with its length of forty feet, trotted upright on its hind legs like a kangaroo. Did those wandering towers embrace each other standing, rock each other upright in their arms, so to speak, as our kangaroos can do with such dash? Perhaps it was while they were thus rocking each other, oblivious of the world, that they carelessly got on soft, swampy ground, in which they sank like leaky ironclads beyond rescue, to the delight of the modern scientists, who thus were enabled to find whole troops of them standing upright, like columns, in the old cretaceous moor, which has long been caked into stone.

Then the largest of all the land animals that ever trod the globe, the Atlantosaurus, which Othniel C. Marsh dug out from the jurassic rock of the North American Rocky Mountains, more than eighty feet long, its thigh bone alone being more than six feet. Imagine the space a loving pair of those Atlantosauri required, even if the male got on the back of the female, as the crocodile of the Nile does to-day. Of all the living creatures on earth Atlantosaurus

seems to deserve the palm for emotions experienced during the sex act. This Atlas dragon, who, if he could not bear the earth, could easily have carried a little house on his back, possessed a strikingly small skull for his brain, quite out of proportion to the dimensions of his body, even if measured by the standard of the brain of other reptiles. But to compensate, the cavity of the spinal column enlarged to such a considerable extent in the region lying directly above the sex organs, that the spinal cord at that place must have been three times as thick as the real brain. Zoologists sometimes speak of a "tail brain" in these animals, a special pelvic brain, which helped control the hind part of the body, especially the enormous tail. But one involuntarily brings this tail-brain into relation with the sexual act. One cannot help imagining the extraordinary nervous excitation that the heaping up of so much spinal marrow substance just in this critical region might very likely have produced.

In the air under the blue sky, high above this ponderous monster, soared the most artistic, the most enigmatic of all the beings of the past world, the pretty little archæopteryx, half bird with wings and a feather dress, half lizard with a long tail and a mouth full of pointed teeth. There is no indication left to suggest what form its love took. Everything regarding its exotic life has disappeared, just as the colours of its feathers, which may have been fabulously gorgeous and varied, have faded down to the monotonous brown of the Solenhofen slate, from which the only two known specimens have been derived. But fancy sees these animals, too, building their nests and laying their eggs according to the manner of birds, sees the sexes chasing each other in the air, sees the male fluttering his powerful tail with its double row of feathers and boastfully declaring the intensity of its love. It is a vanished tale of a vanished forest at the shore of a vanished ocean.

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All this love of a by-gone age is rigid and dead. The lovers are skeletons in museums, skeletons of stone, to which the scientific investigator affixes labels with strange names. However great the storm of that reptile passion may have been, the enormous expanse of time softens it down to-day, as if to a chord from a half-lost melody dying away in the distance. And in such dying sounds barely reaching our ear, the melody continues still further back. the ichthyosaurus, old as he is, nevertheless stands high in the line

of organic evolution on earth, the same line from which in the last analysis, no matter how much scientists may differ as to details, man, like all animals must be derived. In a certain sense we remain in the "family" all along the line. But the line proceeds downward uninterruptedly for some distance below the ichthyosaurus, a distance certainly amounting to many millions of years.

A favourite symbol is the last shore of the known—an abandoned shore, sand and flakes of foam, and then the endless sea of the unknown disappearing in the silver-grey twilight against the white horizon of the inconceivable infinite.

The scientist who follows organic life on earth to remoter and remoter periods knows of such a shore. It lies ready to hand at a certain corner of the recorded history of the earth and is actually a shore.

The place is Sweden. There you find old, very old sandstone deposited in the lowest section of the so-called Cambrian age and partly also in the strata of the still older Algonkian age of the earth's evolution. The Cambrian rocks are very much older than the jurassic slate in which the Atlantosaurus, the archæopteryx, and the ichthyosaurus are imbedded. But to the intellectual vision of the investigator these rocks, too, open up like a book. In the little traces imprinted upon them in Sweden, the active life of a seashore in a world of the remotest antiquity unfolds itself before your view. Although millions of years have piled up on it, like a tower, the old shore, caked into stone, has preserved the most insignificant signs. Here are the trails of the creeping worm, the crustacean, the snail; there, the sand-mould of the stomachic cavity of a jelly-fish resembling a thick cross. The storm threw the jelly-fish upon the shore, where it perished in the shallow waters, as still happens to-day to its blue-hued sister-in-suffering at the shore of the Baltic Sea. And there is the line that the green sea-weed at the shore, easily moved by the waves, has cut in the finest silt.

There is really nothing very remarkable about this ancient shore of Sweden. And yet it exercises a peculiar fascination upon the scientific investigator. It is the last shore he knows containing organic life. We haven't a single plant or animal relic left over from the older strata of rock beyond the Cambrian and Algonkian formations. The condition of the rocks immediately antedating these, a condition they must have reached sooner or later, is a very

peculiar one. Their internal structure is completely transformed. Even if they had contained organic remains, they are dissolved in the mass and are unrecognizable. There is no mussel, no crayfish shell, no imprint of a plant to be found upon them. That Swedish shore is our last, so far as any direct, tangible records are concerned. Here the thread snaps.

The animals that lived on that shore also had their love-life. Who will dispute it? The crustaceans that crept about there must have belonged to the so-called trilobites, extraordinary creatures, now entirely extinct, which must have literally swarmed in the seas of that and the succeeding period. Strangely enough, we can follow the entire course of the development of the young of these animals from the Cambrian rocks of Bohemia. Innumerable tiny little black balls have been found, which seem to be their eggs, and in addition a whole array of the larval or early stages, up to the mature crustacean. No doubt there were love acts among them, too, and erotic emotions to further the love acts. There are in existence to-day certain kinds of crustaceans in which not every female egg requires direct impregnation by the male in order to be able to develop. Generation is brought about by the remarkable process of so-called parthenogenesis, or virginal reproduction, of which we shall speak later. But occasionally sexual intercourse takes place among them also. The crustaceans with which we are most familiar, the crayfish, the lobster, the shrimp, and the crab copulate regularly. In their conduct to the fertilized eggs, they often exhibit a highly developed instinct for taking care of their brood. Special pockets and cavities in the female body protect the eggs, or, as we all know from our crayfish, the eggs are carefully hidden on the posterior appendages. Perhaps those old trilobites put their eggs away, as in nests, in holes they themselves dug in the sand of the seashore, as the extant horseshoe-crabs do, who display the strongest kinship with the trilobites in the entire structure of their bodies. Perhaps the young when already able to swim by themselves, but still weak, remained with their mother for a while and in time of danger hid in her body, as our young crayfish do, who run for shelter to the old crayfish, like chicks to a hen.

The Algonkian-Cambrian shore is the last shore we know of animated with organic beings, animals and plants. The love-life of that shore is, therefore, the last station of visible love that we

can trace historically for millions of years. Here the thread of love, too, snaps.

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Let us put the geological telescope aside for a moment. We must catch up with an idea.

We started out from the immortality of the human race guaranteed by love. Modern investigation was to open up to us new perspectives for this old idea. Suddenly we find ourselves at the Cambrian shore. We see, as in a haze, that love still reigned there. But where is man?

That Swedish sandstone, which was once delicate silt, so delicate that the paths of the trailing worm and the many-footed crawling crustacean could leave their impress upon it—does it not show somewhere the deep imprint of a human foot, the naked foot of a woman, or of a primitive Cambrian maiden, who perhaps walked straight into the joys of love in the golden glow of the sun, which has vanished into the infinite?

Here an out-and-out modern idea interposes, cutting off every fancy of this kind, an idea of colossal weight, which has pulverized entire world conceptions, like a precipitated block of marble, yet so simple that one wonders it could ever have been doubted.

On that primitive Cambrian shore and even before, counting from above downward on the Swabian tropical ocean, which the ichthyosaurus swam, there were as yet no human beings. There were only beings that some day were to become human. They propagated, and through the great principle of Immortality, Love, preserved themselves against the perpetual dying of the individual, as man does to-day. In the course of millions of years they reached the form of man. Henceforth, it was man that preserved himself through reproduction.

We will return for a moment to that simple scene which we alluded to before as the typical starting-point of all philosophy of love. A dying father blessing his child—humanity saved through love beyond the death of the individual. Picture the situation to yourself quite clearly. Look the child in the face and look the father in the face. Are they both quite alike? Both are human beings. But there is a difference; and not merely the difference of youth and old age. The child will become a man. Yet in certain features it will be different from the father, different from the mother, from the parents, from the ancestors in general. It is a

new individual, not merely in that it walks on its own feet, instead of remaining part of the parent's body all through life; it is a new individual, not merely in that it continues to live in full possession of its powers, even the power of reproduction, after the father has died, a decayed old man. . . .

He is an individual, altogether absolutely single within the whole of humanity before him, after him, and contemporaneous with him.

And yet we say that humanity continues to live in him and that his individuality is a link in the chain of that Immortality which is guaranteed by love.

This child will have children, who again will be different. His children will perhaps remain in similar surroundings, and these, in spite of all the differences, will preserve for the grandchildren a certain narrower similitude to their forefathers, which the other human beings do not possess at all. But let the grandchildren wander forth and let them enter a wholly new environment.

History shows us how new nations have arisen through the mingling of old nations.

The Latin races have grown up in this way within comparatively recent times, in the broad daylight of the world's history, so to speak. The modern Americans are in process of formation to-day. We think we see them grow under our very eyes. And yet the component parts that went to make up the historical peoples were already the product of a long process of descent of one people from another. To think that the most naïve believer in the Bible comes more and more to admit without qualms of conscience that the Austral-Negro of the bush and the Englishman, who exterminates him and near his eucalyptus forest, full of kangaroos and ornithorynchi, erects a large modern city with railroads and smoking factories and a modern political constitution—to think that this Englishman and his Austral-Negro have originally sprung from the same sequence of generations that remain immortal through reproduction! How much change all this has required!

Yes, change, necessary change. Our thought must rise to the comprehension that love does indeed guarantee the immortality of generations, but that it is in no way concerned with the fact that these generations as individuals and chains of individuals so vary from one another that in the end, after a series of centuries, the grandchildren and great-grandchildren have diverged from their ancestors beyond recognition.

The modern scientist takes this fact and simply generalizes it to infinity. He asks the question whether a sequence of individuals that includes here the Austral-Negro and there the Englishman might not once also have included a form which, were it placed alive before us to-day, we should recognize as comparable, in fact, in all essentials, identical with the manlike apes of the tropical forests, the gorilla or orang-outang.

Now, all we know from certain remote periods of time speaks strongly in favour of this supposition.

We have said that in a certain region of the Tertiary period all human remains cease. It is devoid not only of human bones but also of all traces of human civilization. To-day the determining feature of entire divisions of the globe is human civilization. Imagine the surface of modern Europe buried in deep stone strata with the immense ruins of all its human industries. But in those rocks you find no mark of man, nothing but the primitive virgin forest, such as surrounds the traveller with its fabulous green in a newly discovered country. And the animals you find in that primitive forest are all on a scale of organization lower than man's. You see apes climbing among the gay blossoms of the primitive trees, where the sun weaves its streaks of light into the green mystery.

Why should not the chain of generations now called "humanity" continue backward through them?

Again an infinite stretch of time. Long-tailed marsupials now leap about in the forest of palms and Araucaria; beings like our ornithorhynchus hide in the moor. In the system of animals now finally established by science after ardent and tireless labour, these marsupials and ornithorhynchi bear somewhat the same relation to the apes and apelike mammals as these do to the highly developed animal man. They stand very much lower on the scale of evolution in the structure of their bones, in their brain, and in the manner in which they mature their young before birth.

In this period of marsupial and ornithorhynchus, corresponding to about the period of the ichthyosaurus, there is no trace to be found of the existence of man any more than in the old tropical ape forest. But neither as yet is any trace of the existence of the ape to be found. Why, then, should not that which later was ape and finally man have at that time had the form of marsupial or ornithorhynchus?

And so on further and further back.

Epochs follow no longer containing the slightest record of the remains of ornithorhynchus. But there are countless fishes swarming in the ocean. That which later lived on land, breathed through lungs, suckled its young, which we called ornithorhynchus, must in those days have had gills on its neck and fins on its body. Ornithorhynchus, marsupial, ape, man were then hidden in the fish.

Finally, on that Algonkian-Cambrian shore, where our knowledge ends, they were probably still worm, an animal in the structure of its body far below the fish, representing, as it were, a still simpler fundamental scheme, which in the fish appears in a much more complex form.

A mental structure, simple and continuous, thus rears itself up before our inner vision. Never is there a break in the chain of love between the Cambrian worm and the human being of to-day. It is an endless series of generations, in which a very gradual transformation in the appearance of the individual takes place, a transformation such as the one that among human beings marks you and you and you of to-day from the old crusader, or the Roman Cæsar in his toga, or the shepherd of mythical Jewish patriarchal times, from whom you are descended through a firm chain of countless love stories, embraces, and births, without yourself being a soldier for Jerusalem, a senator, or a patriarch. You are no primitive Cambrian maiden that went forth in quest of love on that furthermost shore lost in mist. But the worm, which in its fear buried itself in the sand until the ebb of the waters, already potentially contained all the human maidens of future time.

It is only through the kernel of Darwin's theory that the principle of the "immortality of love" is maintained along the line of actual geologic facts back to the primitive shore.

The primitive shore! Not even the Algonkian-Cambrian shore is the real primitive shore. Darwin's theory speaks against it. The jelly-fish, worms, crustaceans you find there are lower organic forms than an ant or a human being. But they constitute, so to speak, only a step down which we can descend still lower. There are in existence to-day an abundance of living beings far simpler in construction and therefore lower on the pure scale of evolution than the crustacean, or even the worm.

The worm is composed, as you are, of organic cells. These cells are arranged in organs in its body; there is division of labour among

the cells, some forming one organ, some another. In this respect, though standing on a lower plane, the worm bears a strong resemblance to you.

Now there are beings entirely devoid of organs, consisting merely of a rough clot of uniform cells. But there is a level even lower, a stage even below the organless beings.

You have heard of the bacillus, the cholera bacillus, for instance, which is always present in the dread disease. Millions and millions of similar bacilli, all microscopically minute, though not all so dangerous, float everywhere in the air and teem in the waters. This is what you read in the papers. But what is a bacillus? It is a living being; and it is the very intensity of its life that under certain conditions makes it so dangerous. But is it an animal, a sort of worm of exceedingly tiny dimensions? Or is it a planet, a sort of grass or fungus? One often hears it called a fungus; and the scientific name "fission-fungi" has greatly contributed to the error. But the bacillus is quite different from the real fungus. It is on a much lower plane of organization and incomparably lower than the worm. Neither the word animal nor the word plant properly covers it. It belongs to a primitive kingdom, from which both the animal and the plant have originated. Only by evolution from the bacillus did the specialization into plant and animal begin. The bacillus does not represent more than a single cell, a single clot of living matter, or, to make use of our previous picture, a single brick. By virtue of its "being alone," however, this single brick is a wee little "house" all by itself.

In the bacillus you have at last actually arrived at the lowest and simplest form of independent life on earth known to-day. It is not necessary for our purpose here to enter into certain moot questions regarding the particular bacilli so dangerous as exciting causes of disease. In a general way you may accept the popular name bacillus as the symbol for an exceedingly numerous series of forms of unicellular beings, which the specialist distinguishes by a large variety of names, but all of which coincide with the genuine bacillus in that they each consist of but one single cell.

Beyond the Algonkian-Cambrian shore there are no remains of animals and plants. The cause is evidently a purely external one. By a strange process of crystallization subsequent to their deposition, the older mud and sand deposits were crushed and jumbled together, as if they had been subjected to the action of a mincing

machine, so that they could not possibly have preserved any records of organic forms. But our fancy need not be controlled by this accidental external condition. If worms crawled and jelly-fish were washed on the Algonkian-Cambrian shore, there must have been a time before that when an ancient sea, now completely vanished, contained still simpler animals, out of which the worms and the jelly-fish evolved. And lastly, there must have been somewhere a final primitive shore, on which only the simplest organic forms existed, forms of the kind not even allowing a sharp division into animals and plants, but from which real animals and real plants were to evolve in the future as two parallel trunks, forms on the order of the bacilli that still exist in such abundance to-day, each of which represents but a single clot of living substance, a single cell.

The bacillus, too, "loves." That is, it exhibits reproductive, propagating processes through which new individuals are created from living individuals, created, of course, in the quite primitive fashion peculiar to the bacillus. Everything about the bacillus has become so "simple," so reduced to the one-brick scale of organization, that its love, too, seems to be based on the thinnest conceivable essence. We will say more on the subject presently. In the meantime let this simple fact suffice. The moist primitive air in which the bacillus floated or the primitive water in which they squirmed or the primitive slimy shore on which they crept, was already the scene of the simplest processes by which individuals fashioned new individuals out of themselves. There was already propagation, there was already love. This is not a vague hypothesis. It is a plain logical inference. As the astronomers once "calculated" the planet Neptune, without having observed him, from certain gravitational disturbances of the nearer planet Uranus, so our biological fancy calculates the pre-Cambrian shore with its pure bacillus love, fully conscious of the fact that knowledge will probably never find tangible geological traces of it.

Now, however, a complicated situation arises On Darwin's ladder we have descended as low as possible into the shaft of millions of years. From the most complicated to the simplest. From man to the bacillus. But now we find ourselves at the critical point. Darwin shakes hands with us and goes. "In the beginning was the bacillus." Whence did it come?

You know the pretty Indian legend. The world stands on an

elephant. The elephant on a tortoise. But what does the tortoise stand on? The priest says "That is God's mystery."

So we are standing now with the primitive bacillus upon our tortoise. The word mystery, however, will scarcely satisfy you.

There is no denying the fact that in the end, so far as the ultimate world problems are concerned, the natural scientist also confronts a mystery. At least he finds himself confronted by a darkness black as night, which his knowledge cannot penetrate. Whence did the world arise? How did the great fundamental motions of the universe begin? What do the visible natural laws of "evolution" represent? These are questions that sink into the great abyss of the general theoretical problems of what constitutes knowledge, which, practically speaking, means nothing else than that they sink into mystery.

The difficulty is that this conception of the "final" in nature apparently cannot be reconciled with our bacillus shore.

The bacillus shore was on earth. However different the surface of the earth may have been from what it is now as regards the distribution of land and water and perhaps also as regards the general temperature, the conditions upon it must at least have been similar to the conditions prevailing to-day. There is a current geological hypothesis that the earth was originally a glowing mass of a sun in miniature, surrounded by sheets of glowing metal vapor and spurting forth tall columns of hot hydrogen gas. In an atmosphere of metal vapours, where iron floats like a cloud and where in the extreme heat not a single chemical combination is possible, even the toughest bacillus could not have existed. The bacillus, it is true, consists of but one cell, but this one cell contains that chemical substance, which in our current conception holds "life" and which "dies" when it is heated to a point at which its chemical composition breaks up.

The bacillus, then, could not yet have existed in that epoch when the whole earth was in a glow. If the hypothesis of the earth's incandescence be right, there must be a point somewhere within the earth's evolution when the bacillus originated, prior to which they had had no existence, and this point evidently must be placed in a time when the earth cooled off to such an extent that a bacillus could live in its temperature.

With the means of knowledge at our disposal, it is, of course, impossible to say positively that the hypothesis, that the earth

was once a glowing mass, is absolutely irrefutable. Its best support is an inference from analogy. Wherever from our earthly observatory we look into universal space, we seem to see phases of a continuous cooling process that cosmic bodies are undergoing. In the nebulæ within even our system of fixed stars, there seem to be cosmic forms still in a purely gaseous state, that is to say, as the earth would be if volatilized to the highest possible degree. Increasing condensation due to volatilization must of itself lead to high temperatures. There are, accordingly, a number of fixed stars which exhibit a condition of extreme white heat. Our sun, on the other hand, apparently nothing but a fixed star in the general scheme of the universe, is regarded as being already in a state of lesser glow. It is held to be of the type of the yellow star, and many astronomers consider the sun-spots an indication of the beginnings of an even more moderate stage, which may be designated as the stage of red heat. With regard to certain other fixed stars, it is pretty certain that they have already cooled off to a feeble red heat. Since cosmic space is as cold as ice, it is clear that in the course of ages the heat of the heavenly bodies would decline. But apparently every body in space has gone through a stage of maximum heat. Why should it not have been so also in the case of the earth? Tiny as it is, it cooled off long ago, so that to-day it does not shed any light of its own and scarcely radiates any heat on its surface. The inference from analogy is strengthened by the fact that the earth's satellite, the moon, a much smaller body, shows signs of being perhaps much further advanced, of having, so to speak, grown even colder than the earth.

To this capital conclusion from analogy are added other secondary grounds. Under the influence of the so-called Kantian-Laplacian hypothesis, we are inclined to imagine an extreme evolutionary progression, in which the earth was at one time hurled from the sun as a glowing ring. According to this theory, the earth is an offspring from the sun, the moon from the earth, and the sun, of course, from other fixed stars. This hypothesis presents many difficulties of detail, and it is doubtful whether it will hold. I have no desire to lay particular stress upon it here. However, he who believes in it is led directly to the conclusion that the earth was originally a glowing mass. It has also been directly inferred from the flattened condition of the earth at the poles that it must formerly have been more plastic and therefore more fluid. A hot

fluid mass would suit this theory best. Others think that a solid ball of ice would also have flattened in the course of time through the displacement of its parts. There are a number of other hypotheses pro and con. But on the whole the result reached by scientists in so many different ways is so similar that it is impossible not to believe that there is some truth in the theory that the earth was originally glowing hot.

At any rate, for our imagination the general evolution of things is thus removed even beyond the primitive terrestrial bacillus shore. It is only beyond cosmic condensations and coolings that it drops into the darkness of the totally inconceivable, the totally mysterious. But within the still conceivable series of evolution there begins, beyond the primitive bacillus shore, the red glow of the terrestrial sphere, which seems to set the limit to the bacillus, to life, to love.

Remember now once more. Man was latent in the primitive bacillus. He is descended from the bacillus through a chain of reproduction inwardly continuous but modified by evolution. Back to the bacillus, through love, the thread of immortality stretches firmly without ever snapping. But what now? Whence came the first bacilli on the border-line between the glowing hot earth and the cooled earth?

The scientific investigator performs a sharp incision. For him everything from the first bacillus of the primitive world to man to-day runs along the golden-fated thread of reproduction. But the first bacillus must have originated through spontaneous generation.

This is a most peculiar concept. We began our observations with the great picture of sexual reproduction in living man of to-day and then descended into the pit of æons in quest of its deepest philosophical meaning. We must now pause a moment and face the situation squarely. . . .

§ 5

Nature is God the Father's child,
The loveliest of women frail,
She found a faithful wooer mild
In man's keen spirit on her trail.
They loved, and not unfruitfully:
A noble offspring saw the light.
Thus it is clear for all to see:
Natural philosophy is God's grand-daughter bright.'

GOETHE, *after Dante's Inferno, Canto XI,* 98

Spontaneous generations! If we open up an ordinary text-book under the heading of Reproduction, we are likely to find two definitions, one for real generation, that is, the one to which you owe your own existence, and the other for spontaneous generation or abiogenesis. The paragraph usually adds that the latter form of generation has never yet been observed, that is to say, it actually does not take place.

The book, however, immediately limits this statement, either openly or hesitatingly, according as it is more or less Darwinian in its tendency, and declares that historically spontaneous generation must have existed at least once, for the first appearance of life.

When I read such paragraphs I always think of the splendid answer of the theological student Jobs:

A proper sermon has two parts
One that no mortal can take in,
Another one that can be seen.

Spontaneous generation is certainly the most complicated chapter in the whole philosophy of reproduction.

The text-book is right. There is no shadow of evidence to-day that spontaneous generation takes place. In the time of old Aristotle, people were satisfied that mice and fleas developed from dirt. The maggots in the cheese arose spontaneously from the cheese. And even down to the nineteenth century—down to the good

Leuckart some assumed that the tapeworm in your body is a parentless product of the matter in your own intestines. All this has now been proved to be nonsense. The mice under your floor and the fleas in your bed, the maggots of your old Limburger cheese, and the tapeworm in your intestines have all been normally produced, like all the higher animals whose existence hangs securely on the great tree of life, through successive generation from individual to individual. But careful scientific investigation of even the lowest organisms, the bacilli, has yielded no results. All experiments in this connection have proved futile. Either abiogenesis does not take place to-day at all, or we have no adequate means to discover it.

An exception must, therefore, be made for the first bacilli for their appearance upon earth the "first time." For these first bacilli something must be assumed which would distinguish them fundamentally from all their descendants up to yourself. We must suppose that, having come into existence, they exhibited love acts, propagating themselves by the simplest mode of reproduction. But they had no act of reproduction exerted upon themselves.

If this be so, then we have now actually arrived at the "origin of love." Figure to yourself (in these ticklish old stories, the details do not matter very much) the first bacillus at the boundary line of air, water and earth that is, at the seashore—figure to yourself this bacillus suddenly arising out of "dead" matter, out of some inorganic compound. Then the moment of its birth, when it springs into life with all its capacities, would also be the moment of the great birth act of love as one of those capacities.

Why, strictly speaking, there need have been no more than a single bacillus and how through the remarkable process of self-division it could create its own Eve for itself—about these things I shall tell you later. At all events, this first bacillus was the Adam and the Aphrodite of life in one.

It is more than a mere jest if in this connection you recall the old myth of Aphrodite, who in a sacred moment sprang from the foam in her naked human beauty.

True, it is a very long way from the crude clot of living matter, the single "cell" of the primitive bacillus, to the complete glorious naked woman's body, which love has consecrated to the loftiest beauty. But in the ultimate analysis it is love that has conditioned that way. The bacillus produced numerous offspring upon which

eternal circumstances and internal conditions continually reacted, until in a chain of myriads of individuals produced by love, the formless primitive being evolved into Aphrodite, the ideal of the naked beautiful woman of the human species. The myth mixes things up a little and raises Aphrodite directly from the foam. The natural investigator requires a few millions of years for this event, a gay procession of animal forms, in which, always conditioned and promoted by love, the ascending series of living beings clothed themselves, until it reached the human being—gastræa, worms, fishes, amphibia, primitive reptiles, ornithorhynchi marsupials and finally apes and the manlike apes. But in principle this is not very material. The important fact is, that once upon a time on a hallowed day of the hoary past, beyond all earthly colours known to us, love seems to have arisen out of mud.

Follow up the thought one step further and I will have brought you where I want you to be. In the realm of the old Greek mythology Aphrodite, through a mystical act, arose out of the foam. Gæa, the Goddess Earth, gave birth to Uranus, the generative force of the sky. Uranus gave birth to the Titans through union with his own mother. The Titan Cronos emasculated the father and cast his genitals into the ocean. They dropped into a foaming wave and from the foam rose Aphrodite. Gods and mysticism.

Now consider the grounds on which modern scientists have based the hypothesis of "spontaneous generation" at that ultimate dividing line of life fronting the red glow of the ancient earth.

As a strictly scientific hypothesis, it has made its way gradually in the nineteenth century in opposition to the Darwinian theory. It had its origin, not in scientific investigation and the scientific mode of thought, but in a certain false mysticism and its ineradicable tradition. Springing from religious dogmatism, this assumption drifted about for a time, as it were, homeless in the modern world of thought, when suddenly it perceived in scientific geology a raft on which it seized as a possible rescue. Formerly the earth was fire, incapable of supporting life. Later the earth exhibited life in a tangible form. Surely, at this point the "wonder of creation" must have intervened, concluded the philosophers that clung to certain religious principles of faith. The first bacillus dropped out of the "hand of God" through a mystical act. Consequently, to speak from our point of view, love must also have been "created"

on the border line between the glowing state in which the earth was uninhabitable and the cooled state in which it became habitable.

There is something tragic in the way in which such ideas, for which the word mysticism in its nobler sense—and it has a nobler sense—is far too lofty, have in our century gone wandering about in search of a haven in the logical human intellect. At first old tradition was as firm as a rock. Six days of creation, days in the literal sense, and all was done, the earth, the light of the world, the worms, the flowers, the birds beneath the sky, Adam and from his rib Eve—all the creative power of God, hurled with one thrust into reality out of the mystic Inconceivable, as in Michelangelo's picture. Then came science. Advancing gradually, sucking, power-absorbing like a wicked sea polyp. One could not very well lightly dismiss a large part of geology, with its enormous intervals of time, with its endless terrestrial epochs succeeding each other, like acts of a gigantic drama that laughingly rejected all the Aristotelian unities. A good part of Darwinian evolution also became too plausible to be denied. "Creation," that pretty poem which, while held in the thraldom of narrow dogmatism, strayed into the world of "knowledge," fluttered hopelessly over the threatening waters of the geological underworld. Suddenly, lo and behold! Here is another point of dry land, the dark moment of the origin of "life." Here at least, apparently, was an absolute beginning without evolution. And the weary fluttering metaphysical thought dropped down on this spot of the world's map, like one of those poor butterflies which the seafarer sees tumbling down on the rigging. Surely, here before the primitive bacillus, the hand of God must have interfered, even if he had done nothing else in directing the course of the universe.

But now the very doctrine of spontaneous generation faced about and vigorously attacked the last position of the unscientific concept of creation. Here also science absolutely demanded a logical sequence of events instead of magic. You know the pretty legend of the stones that spoke when human folly was silent. And so, when the voice of life seemed to fail utterly, the unflinching spirit of scientific inquiry raised "dead matter" from its sleep. Yes, spontaneous generation. But spontaneous generation means simply the origination of life from inanimate, inorganic crude matter, capable of evolution by virtue of the laws that govern it. It does not imply supernatural intervention.

You must fully realize this distinction before you can thoroughly grasp what the hypothesis of abiogenesis in the scientific sense signifies, what it must perforce signify. In order to remove the mystic act of violence, with its unmotivated suddenness, spontaneous generation must itself be logically brought within the sphere of the idea of evolution. It must under no circumstances represent a jump! It must be a bridge.

As soon as we have a clear understanding of this point, the question of spontaneous generation, I think, loses very much of its strangeness. It becomes far more flexible and instead of being a bolt furnishes an open door for further thought. Our own particular problem, too, will be greatly advantaged by a thorough understanding of spontaneous generation from this point of view.

Think it over as clearly as possible.

If I say that inorganic, lifeless matter, matter to which life is foreign, one day suddenly turned into a bacillus, a living cell, then it means a jump. In such a definition the two things are quite distinct from each other. If I presume, further, an act that "makes" one into the other, then it is an act of violence.

But it is different if I say that the bacillus "evolved" from inorganic matter that previously was not yet bacillus. I then take for granted that the two were in some way related to each other. The inorganic matter could become bacillus. It must, therefore, have contained the prerequisites for it in precisely the same way as the bacillus must have intrinsically contained something relating it to the human being, something that led on to the human being. Otherwise it could never have become man. If our hypothesis naturally derives the bacillus from inorganic matter, it of necessity involves the assumption that inorganic matter had the prerequisites to the bacillus existence, that is, the prerequisites to life. For life to have arisen from it in the form in which it is exhibited by the bacillus, there must have been certain elements of life in inorganic matter itself, not in the sense, of course, that it was actually incased in it, that there were bacilli mysteriously encysted in "dead" nature from eternity, but in the sense of a potentiality, a tendency of evolution, which under certain circumstances could be, and actually was, heightened.

In order to be able to derive the life of the primitive bacillus from inorganic matter at a certain time upon the freshly cooled earth, you must conceive of "inorganic matter" as the great comprehensive

general concept, which contained from the beginning and still contains the roots of the so-called organic or the living.

As to the way in which this idea is to be represented in the narrower form, there is a whole bouquet of possibilities.

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Visible inorganic nature is, as you know, divided into a number of fundamental substances or elements, which cannot be further decomposed. Gold is such an element, so is lead, the oxygen of the air, and the hydrogen in water, the sodium in the cooking salt, the quicksilver in your thermometer, and so on. It may readily be imagined that one of those fundamental substances may from all the way in the past have been a special carrier of the capacity of life.

Strangely enough one of the elements, namely, carbon, actually does play quite a remarkable and determining rôle in all organic matter, in the life and functions of all the cells from the bacillus to yourself.

When the earth was still at white heat, like Sirius, and could not tolerate any chemical combination of the elements in its terrible furnace; when the viscid cell mass of the living bacillus therefore was still non-existent upon its surface, then, according to this view, the pure carbon floating freely in its glowing atmosphere must have been the presaging evolutionary member of "life" containing the bacillus potentially, as the bacillus later contained man potentially. Scarcely was the earth cooled to a temperature rendering a sufficient number of chemical combinations possible, when a part of the carbon on the earth immediately became cells, bacilli, "life," in the narrower sense.

This very simple view, which because the evidence we possess on this subject is so meagre, can neither be strongly contradicted nor positively established, leads to certain inferences, which take you a long way further.

Carbon certainly seems to be markedly distinguished by definite properties from the other elements of nature. Yet you class it with the elements just as you include the ant and the ape in the same class of animals. In many respects ants and apes are very far apart. Nevertheless, they bear a certain relation to each other. Darwin tells you that they are related by descent; though they may be very remote cousins, at two opposite extremes on the tree of descent. So it is with the elements, with gold, iron, sulphur and carbon. Of some we say that they are more nearly related to each

other, of others that they are more remotely connected. They certainly exhibit relationships, relationships of various degrees; but they all have something in common. Darwin's theories of evolution, carefully and judiciously transferred to modern chemistry, suggest that in this field, too, the general systematic relationship is, very probably, an actual relationship of descent. We surmised that the elements as now constituted must have been historically evolved from each other by groups. The speculative chemist of to-day again dreams, like the alchemist of old (excepting that his dreams are based on more methodical thinking), of the possibility of again transmuting by certain definite means all the sharply distinguished fundamental substances or elements one into the other, or, perhaps, even of resolving all the elements into one ultimate fundamental substance. This speculative notion seems to have obtained its first secure foothold in the famous discovery of radium, which, it is claimed, can be transformed into helium. The astronomer, too, who in certain huge suns finds the number of elements continually reduced in the spectrum analysis until the very loose nebulæ appear as clouds of but two or three primitive substances—the astronomer speculates as to whether in those nebulæ we are not directly observing such primitive states, states in which only two or three of the elements have developed instead of the many which the less hot sun and the cooled earth exhibit.

Thus, beyond the white-heat earth of long ago and beyond the sun, your carbon with its life-content can scarcely be conceived of as isolated. It flows into the endless cosmic stream of the evolution of the elements. There its marked properties, its individuality, only a stage in the evolution of the whole, must ultimately lose itself in the deepest depths of this whole.

Thus, the chain that ended with the bacillus, even if narrowed down further to carbon, must at last sink into the universal cosmos; and with this, finally, into the great ultimate mystery.

But you may, with the same end in view, strike out into paths of speculation. Making no very special exception of carbon, you may start from the general proposition that all inorganic matter is in a measure "animated" from the very beginning. Under certain conditions, certain definite forms of life originated from it. One such form is that which we see in the chain from the bacillus to man on our cooled planet, the form that in all respects best

corresponds to the conditions of adaptation on the surface of the cooled earth. But this visible world of carbon cells, which has existed on the earth since it cooled, really represents but one of countless "possible" forms of higher evolution.

If you wish to let your fancy play, you can imagine that the line which began with the bacillus was itself the product of evolution from other lines, that these lines were adapted to different conditions, their growth being favoured not by relatively cool temperature but by glowing heat. A chain of life may have already been in existence on the earth when it was in a condition of red heat. If so, this life was, of course, connected with elements and compounds that could remain undecomposed in such heat. And so we can go on backwards. According to this hypothesis, there may be a relation between our cell life and certain cyanides, chemical combinations that may have first developed under a very high degree of temperature, such as is chemically required for this cyanide world. All our so-called "life" with its definite cell substance would, in this conception, be merely an adaptation to a certain temperature. A different life adapted to a different temperature would have evolved as organically as in our own life the land animals, for example, evolved by new adaptation from the water animals. In a certain sense, our life may be designated a flame kindled the first time by a great original heat, and now continuing to burn softly, ever regulating and rekindling itself. Wilhelm Roux, the great physiologist of Halle, carried out very brilliantly the striking analogy between a flame and a living cell continually regulating itself through the change of substances.

This idea is interesting both in itself and in its bearing upon the future.

When the primitive bacillus came into existence the temperature of the earth in all probability was generally higher than to-day. In the course of millions of years the earth periodically cooled a little. But the chain of terrestrial life through these years seems to have readily adapted itself to every decline of temperature. The warm-blooded animals arose strongly equipped for higher degrees of cold. Finally man appeared who made the radical discovery of how to produce fire artificially, man who to-day can easily endure the sunless polar winter. Has nature already found in the creature man, with his genius to invent, his ability to transmute one form of energy into another, the appropriate new form of adaptation that

will secure the further evolution of life even in an epoch of the most rigorous cold; an epoch in which the cold that previously chilled the earth to the point of making possible the evolution of the bacillus will also overcome the sun and so plunge the earth into an endless polar winter? Will man through his machines reach such perfection that some day he will be able to solve with the ease of play the problem of the cold in cosmic space? Will he in a future glaciation of the world, far from freezing into an ice mummy, far from perishing miserably, with all his culture, as our faint-hearted prophets are so ready to predict, will he through his very culture as man become the bacillus, as it were, of an era of life, defying the cold of several hundred degrees, as the bacillus once defied a decline of temperature from red-hot to perhaps some forty degrees centrigrade?

But that only by the way.

The essential thing is, that this second hypothesis also leads life uninterruptedly to the boundless evolution of stars, and sets the problems of life to rest by bringing it up to the region of the inconceivable, to the finality of cosmic things and causes. The mystery inherent in matter as a whole being a fundamental phenomenon of matter, its tendency freely to evolve into life naturally also falls into this mystery. In this regard the second road leads to exactly the same point as the first.

One thing more remains to be considered for both hypotheses, and the discussion of this question will, after some digression, very properly lead us back to our problem of life.

The question naturally arises, which of the visible living phenomena are to be considered inherent as a general "vital tendency" in all matter, or, if you will, more narrowly, in carbon, and which are not to be so considered. This is practically the most knotty question in the whole subject.

Your answer will depend upon whether or not you recognize certain conclusions as logically correct. Is "sensation" the basis of life, and to enable it to evolve cells, must inorganic matter in some form or other contain sensation? This question is especially perplexing because it is difficult to conceive of sensation without consciousness. However, confused minds may dispute it, it is nevertheless true, that for the simplest sensation a feeling ego, that is to say, a consciousness is necessary, not, of course, a clearly reflecting

self-consciousness in the human sense, capable of perceiving what passes in itself, but a naïve, direct, intuitive consciousness. Has every atom of carbon, in fact, every atom of all the elements such a consciousness? And, further, is "memory" a fundamental property of all matter?

You see, you are now approaching the most intricate problem; you are touching upon the province of the "soul." Whether you regard the soul as merely a material product; or whether, in the parallelistic sense, you take it to be a phenomenon constantly accompanying the physical processes; or whether you assume that the whole seeming distinction between what pertains to the soul and what pertains to the mechanical is merely due to the twofold way in which our mind sees one and the same thing; in any case the most significant psychic characteristics of life together with the mechanical here slip through your fingers into the world of the inorganic.

In order not to lose ourselves in a boundless sea, we will keep strictly and narrowly to our subject. To the fundamental phenomena of the bacillus belong also generation, propagation, love; and the question is, whether we can transfer these beyond the bacillus to the inorganic. To make use of our figure again, when Adam sinks in the primordial mystery of things far, far away, before the bacillus and the earthly distinction between the organic and the inorganic, then does Aphrodite go as far back also?

I think I have now carried the whole chain of inference sufficiently far for you to see that it is possible. However, we are moving in a haze, where direct answers are excluded. The question is, what significance you want to attach to further analogies. Everything depends upon that.

Note the abundance of phenomena in the process of propagation among living beings. You saw the details of the most fundamental of them in the generative act of human beings. Later I will present other cases. For a number of those phenomena there is no doubt that similarities of analogies can be found in the field of so-called inorganic substances.

For example, a fundamental factor in propagation, whether highly developed or not, whether in bacillus or in man, is the previous existence of an individual. You are an individual, your wife is one, your son is one; this sparrow is an individual, and that lizard is an individual. Closer examination will show you that the concept individuals in animals and plants is not always so very easy to grasp.

Nevertheless, it may be said with truth that the whole story of love in the world of life is really but a section, a chapter of a much more comprehensive book, the story of an individual. The individual may be of the simplest possible construction. It may be a bacillus, consisting of but one cell in contradistinction to you, who are built up of myriads of cells. But to make the process of propagation at all logical, the individual must be there; that two may arise out of one, there must first be one. Even in the bacillus, propagation was based upon the existence of isolated individuals. And in you, in man, two individuals are a necessary prerequisite to the act of generation. But even assuming that the mother alone is necessary to produce the child, the existence of an individual, the mother, is absolutely binding.

It is interesting to observe that even simple inorganic nature has already reached the stage of forming individualities. A very striking example is furnished by crystals. Examine a pretty phase of rock crystal; or admire the charming snow crystals that have fallen on your black coat. But a similar tendency is observable in other cases. With your telescope you see a continuous chain, continuous phases of individualization in the realm of the stars. The formless nebula breaks up into groups of stars, sun next to sun. In each solar system the matter seems to subdivide into planets, and around each of the large planets into moons. In the end, everything in siderial space seems to be standing alone, an endless series of individuals, each sharply divided from the other. On a large scale, it is true, these individuals are combined into systems, but in a narrower way each constitutes a unit by itself, each pursues its own development. Consider, for example, what a characteristically marked individuality, on the whole, the earth is.

Further, in the field of chemistry, which has gone most deeply into the study of the inner nature of inorganic substances, you find yourself everywhere emphatically brought face to face with the existence in the compounds and elements of certain minute individualities, and other individualities even more minute. The whole science of chemistry consists essentially of the investigation of their individual behaviour and interactions. The chemist, by a sort of logical necessity, deduces them from his calculations even where all possibility of observation is excluded. There is something individual in the different pure mineral substances, especially in the elements. But beyond these differences of kind, as the last resort, so to speak,

we find both in the compound and the element the real individuals, the molecules, and the atoms. Of these the atom (disregarding the still more far-reaching modern hypotheses of chemistry and clinging for the moment to the older conception) represents the most distinct and most permanent individualized form that we know of in the whole world of matter.

Take another case. A fundamental phenomenon of propagation is the division of an individual for the purpose of producing a new individual. From you the spermatozoa breaks off, from the woman the egg-cells. The union of the two results in a human being. In lower animals the division is often much more radical. Instead of throwing off merely a tiny little part, the whole parental individual breaks up into two or more pieces; and the breaking up is distinctly the result of growth. A bacillus takes food. It grows up to a certain point, when, suddenly, a new peculiar natural force seems to assert itself. Till then a certain natural force held it together as an individual; growth did not affect it as an individual, the maturing force seeming to keep pace with the increasing size. But when the growth exceeded a certain limit, the new natural force suddenly made its appearance. It rent the individual asunder. It split it into two pieces, two individuals. Without knowing the real nature of the forces at work, we simply say that the bacillus has propagated itself.

There is essentially no difference between the process taking place in you and the process taking place in the bacillus. As a child you are merely one, the individual "you." You eat eagerly, you grow; but the time comes when you are no longer a child, but a youth, and the excess of food you take is no longer entirely consumed by your growth in height, by the development of your beard, and the like. Numerous spermatozoa separate from you in the reservoir of your sexual apparatus, and these spermatozoa are eager to break away from you. With all the means at their command they seek to detach themselves from your individuality, in order to find each for itself a female egg-cell, in combination with which to build up a new individual, a new human being, independent of you.

Now observe an inorganic process, a very simple one. From the ceiling of a cave a drop of water hangs suspended. It has trickled down through a fine crack in the rock, and the action of a certain natural force holds it at the ceiling. Hanging there as it does, all by itself, it may be regarded as an individual. More water runs

down through the crack. For a time the drop merely absorbs it, eats it up, so to speak, incorporating it as part of its individuality, and, of course, grows as a result. The natural force holding it at first seems to keep pace with this growth. The drop remains clinging to the ceiling. But growth proceeds rapidly, and suddenly a climax is reached. From its continual feeding the drop becomes too "heavy." The tremendous attractive force of the earth drawing it downward to the floor of the cave exceeds the other, relatively weak force that has hitherto kept the drop fastened to the ceiling. All at once the drop is rent asunder with a jerk. A small part remains at the top clinging faithfully to its old place, but the severed part falls with a splash. With the upper remnant rapidly filling through growth from the feeding crack, and with the other part falling to the ground, forming a new drop, you now have instead of one individual two individuals. Isn't this an analogy? You reply the phenomenon is simply due to the action of gravity, whereas the forces in propagation are of quite a different nature, acting from within outward. Far be it from me to say that the bacillus which divides itself, or that you who liberate a spermatozoon from yourself are forced to do so by simple gravitation. But here we are not concerned with the kind of forces that enter into play in these phenomena; we are simply interested in the general analogy. You are to understand that division as a result of growth is quite plausible and conceivable in inorganic as well as organic matter.

A third field. The whole province of propagation is pervaded by phenomena to which you give the spiritual name of sympathy. All "love" in the narrower sense is sympathy. Man and woman seek each other. They feel a decided inclination for each other. They are fired with a yearning love impelling them to unite. They feel attracted to each other.

In this last expression you have the mechanical substitute for he concept of sympathy. Attraction is a term that may be applied in the inorganic world.

However complicated the paths that attraction follows in organisms, even if not exerted directly, but by way of the senses and the nervous apparatus, even if requiring the intermediation of optical impressions, and, above all, apparently, of smell impressions, in essence it remains "attraction."

In this connection recall that "primal phenomenon" from which

we started out—how in your human-love act the male-cell penetrates into the egg-cell. It may be—there are many indications pointing that way—that even this most intimate, final, and cardinal act of your entire love follows the path of the senses. If so, then there is no doubt that the ripe and ready egg-cell and its nucleus exercise their influence upon the spermatozoon through smell.

But it is clearly not to be denied that the whole intimate process exhibits a most striking resemblance to certain forms of direct attraction with which we are familiar in inorganic matter. Careful, almost too critical observers of the act in animal eggs have no hesitancy in comparing it with "electrical attraction." In eggs of the so-called sea-cucumbers, that is, animals related to the starfish and the sea-urchin, the microscope reveals the spermatozoa rushing to the egg, recoiling from it, rushing back and clinging to it; a changing play so similar to the dance of alternately attracted and repelled particles on the conductor of an electrical machine that the comparison absolutely forces itself upon the observer. A similarly wild storm in the interaction between spermatozoa and eggs was observed in plants, for example, in the well-known bladder-wrack found everywhere on the northern sea-coast. The spermatozoa carry on so madly in their onsets upon the egg (think of it, in a plant!) that the impact sends the very inert and comparatively huge ball of the egg turning on its axis.

Now reflect how so-called inorganic "dead" nature is everywhere full of attractive forces, which seem to pass simply from body to body—gravity, adhesion, magnetic and electrical attraction, chemical affinity. The whole mechanical world as we see it is, in fact, based upon these attractions.

Again, far be it from me to persuade you that erotic attraction is identical with this or that form of material attraction. The arbitrary mixing-up of magnetism and love has brought about enough confusion among those who think only by halves or quarters and has not helped us advance one inch further. In themselves gravity and love are as different as can be. When you fall from the window, the force of gravity seizes you with its fearful vulture claws, whether you are completely dazed, deaf, blind and benumbed, or whether you have all your senses and wits about you. It seizes you in proportion to the mass of your body and asks no further questions. Erotic attraction, on the other hand, requires your senses, and does not in the least concern itself with your weight.

Clearly, then, you cannot throw these things together in the same pot.

Nevertheless, the fundamental analogy holds good. Propagation, love, uses a means, a mode of force, if I may so express it, which is at home everywhere in nature, regulating, in principle, your compass, your position in the solar system and the fate of your spermatozoa.

Attraction leads you directly into the province of chemical elective affinities, the province which, since the appearance of Goethe's gigantic work, is the classic ground for analogies between erotic and inorganic processes. In this instance, too, the analogy will be pure only if, for the time being, we disregard in a measure the most difficult problems of human soul life, and confine ourselves to the egg-cell and the sperm-cell.

The semen, representative of the male individual and apparently burdened with its fixed hereditary characters, itself, therefore, in a certain sense, quite a pronounced individuality, meets with the egg, which is in the same position as the spermatozoon, except that it represents a female individual different from the male. The act of generation follows, and both fuse. A third, absolutely new individual arises, which, whether it turn out to be man or woman, possesses something of both the father and the mother, yet is neither father nor mother, but a new, independent being, so much a "unit" that we cannot conceive of anything being more of a unit.

Now throw together certain chemical elements under certain appropriate conditions. In accordance with an exact law, atom will rush to atom, and an absolutely new, a third body, which is neither the one nor the other, will result as the product of the two. Hydrogen, a gas in our average temperature, combines with oxygen, also a gas; and the two gases combined produce the liquid water, which is different in every respect from both.

There are in the same example still further analogies. Marvellous laws govern the combination of the male-cell and egg-cell. You cannot produce a human being with semen alone. In the whole world of organisms with sexual reproduction, the egg, individually different from the sperm, is essential for generation. But the difference, too, is of a different kind in different organisms; the difference, too, is sharply delimited.

You will in vain carry your own living spermatozoa to a sea-urchin's egg-cell ready for love. While the sperm-cells of the sea-

urchin pounce madly upon their female partner, the foreigner's sperm-cells remain inactive. They do not swallow the bait, so to speak, and generation does not take place. Real elective affinity prevails, restraining the play of love in the thraldom of quite definite laws. The very same is true of the atoms of the elements. Neither do these combine blindly, any atom at random with any other atom. There is a stubborn choice of appropriate partners, in many cases, of very definite partners. It is a grand play of mysterious elective affinities.

Once again, I do not mean to imply that for elective affinities the analogy by any means amounts to identity. The organic process of love, even if reduced to the simple form of male-cell and ovum-cell, is like all organic things, a matter of infinite complexity and refinement, which the play of the atoms can never parallel. Nor will you make two cases identical by speaking of the "hatred" and the "love" of the atoms.

From a certain point of view there is no valid objection to the expressions. As I told you, the antecedents of life slip through our fingers and drop down into the world of the inorganic. But if that be so, then the soul, the psyche, also passes into the world of the inorganic, beyond the bacillus.

In speaking of the hatred and the love of the atoms, you are merely doing the reverse of what you did when you spoke of "attraction" in the sperm-cell and the egg-cell, attraction being originally a purely mechanical concept. In the case of the male-cell and the ovum-cell the concept of soul and sense stimulations and sensation is the most natural to you, because you see a human being eventually arising from the fertilized egg-cell. In fact, you know that you yourself have sprung from a fertilized egg-cell. In chemical elective affinities, on the other hand, it is the mechanical conception, the conception using the word attraction in somewhat the same sense as gravity and magnetism that is at first uppermost in your mind.

But there is really no logical reason why you may not reverse the meaning of the terms, or at least extend the psychic conception to include the atoms. That in organic generation there are spiritual processes is not a matter of direct observation, but an inference. You infer them from yourself, just as the assumption that there are other souls beside your own is merely an inference, not an observation. Strictly speaking, you never perceive with your senses the soul of even your most intimate friend. All you perceive are me-

chanical effects following each other in a certain sequence and manifesting themselves in a certain way. By analogy with yourself, you "invest them with a soul." If now in their sequence and manifestations the organic and chemical elective affinities seem strongly to resemble each other, and if no other scruples keep you from extending the "soul" beyond the organic, then you may calmly make an inference with regard to the atom, too, and instead of attraction and repulsion, say love and hate.

Still, this is no reason for regarding the two processes as absolutely identical. Do you not see the huge gulf separating you, the human being, with your world-embracing intellect, from the bacillus, notwithstanding the fact that both of you exhibit genuinely psychic processes? And what a wide gulf there is between the love act of two organic cells each of which, let us say, corresponds to a bacillus and the "love" between a pair of elements, the oxygen atom and the hydrogen atom, in the chemical act of combination?

To reiterate for the last time. We do not expect, nor do we find, identity. We do not require the bacillus, that sharply defined evolutionary stage in nature, or the egg-cells as such to be contained in the atom in the sense of being actually encysted in it. They are no more contained in the atom than man is contained in the egg-cell as a homunculus, which on enlarging will some day be visible. We are only looking for a basis in the organic world which will show us as a potentiality that which in the bacillus and in the higher types of life has assumed a definite form of adaptation, a form that apparently came into the existence upon the earth but once.

This, I think, the analogies—all to be taken *cum grano salis*—have actually shown you. The individual parts of the concept of love and propagation seem to be sailing about everywhere in inorganic matter. The bacillus and its descendants up to man have, to use a previous figure, only caught it as in a sun-glass.

We may now take leave of spontaneous generation. It is possible that Aphrodite, too, floats in the endless blue of all cosmic evolution; she becomes element, atom, star, primordial substance, the final mystery.

What thou lovest thou wilt be, Man, of this be certain,
If thou lovest God, then God, If the earth, then earthen.

ANGELUS SILESIUS

§ 6

We have wandered in Milky Ways, at Nature's dark confines.

"There lay the world, a water deep and bright,
Isles floated after isles—a gleaming light."

as Heinrich Hart's beautiful poem of Man says. The other end of the great rainbow of love vanished in the furthermost blue of those watery depths. No intellectual diver, however bold, can penetrate to it below.

Above, however, under the bright variegated span of the rainbow, your eye now perceives form after form, an endless procession, the visible forms between the primitive living beings of the earth and yourself, myriads of strange grotesque creatures whirling up like the day-flies, crowding like the fish of the ocean, up, up, through the millions of years, along the clinking chain of which the history of the earth advances. From the bacillus to man: a phantasmagoria more gigantic than Dante's vision, Hell, Purgatory and Paradise.

The earth was. It was habitable in the present sense. The first forms of life appeared, of the kind to which, in the highest type of evolution, we were one day ourselves to belong; and with them love in the narrowest sense of the word began.

Let me continue with my story.

You know, the place from which we started, where the one foot of the rainbow spread its garish colours upon a landmark, was your own human act of reproduction. A single cell, a spermatozoon liberates itself from you, the man, and unities with the woman's cell, the egg, likewise liberated. From the union of the two, a new human being arises. In the beginning of terrestrial life, however, in the ancient days, long before the time of the Algonkian-Cambrian shore, there was as yet neither human male nor human female. There was neither human sperm nor human egg. But there were beings from which some day, in the endless succession of evolution, human beings were to arise.

These beings were, as was said, the simplest conceivable. Each

represented but a single living cell, just as each of your spermatozoa is still a single cell, and as each egg of your female partner is a single cell. The love act of the human being consists in uniting these two single cells. Upon love acts depends the infinite chain of evolution from the one-celled bacillus to man. Now, what was the love act of that first-born one-celled being at the beginning of the whole line of evolution? Did one unicellular animal of that time seek a second unicellular animal, as the spermatozoon does to-day, and did it declare its love by completely fusing with it, as the spermatozoon fuses with the egg?

Here I must call your attention to one fact.

The act as you see it in yourself is not merely an act of love, a general act of reproduction. It is more. It is a sexual act. Two sexes are necessary for this act, man and woman, each with special sexual parts and with special sexual material. It is the sexes as such that accomplish the act of sexual generation.

Here another great question arises. Did love in the sense of generation or propagation, of an immortal principle transcending the individual, did love from the very origin of life on earth begin with duality of sex, with a genuine sexual act of two individuals? Or was duality of sex a form that has evolved from the primitive love of the simplest living beings on earth?

Understand me well. To give you a picture, think of the biblical legend of creation. God by a sort of mystical act of spontaneous generation created Adam from an inorganic lump of earth. From his rib Adam with the help of God asexually begot Eve. Then he united with Eve for sexual reproduction, and Eve begot children in the normal way, in accordance with the generally prevailing human custom.

In this legend sexual generation is apparently only the last, the third stage. The scale of ascent is: spontaneous generation; simple generation without duality of parents through a sort of direct sprouting from the body of a single individual; finally, sexual generation between man and woman. The legend, it is true, gives its own mystical interpretation to stages one and two. But we can set that aside. You saw how spontaneous generation can be conceived of in a purely scientific way without the supernatural element. As for stage three, even in the Bible the real sexual act is quite devoid of the supernatural. Why not consider for a moment whether stage two also cannot be taken simply as a symbol for an actual

primitive process? Though not constituting knowledge in the modern scientific sense, such old popular legends yet contain a certain logic of speculation. Our Adam is the primitive bacillus, some one-celled primitive being, in which man, too, like all other later living creatures, was contained in primitive potentiality. Did not the primitive bacillus, like the Adam of the legend, propagate itself without dual sex? Did it not divide itself, so to speak, into Adam and Eve, that is, into male and female.

This sounds like scholastic hair-splitting. Yet, where the scholasticists, the merely speculative philosophers, the believers poring over a text dim with age, had to spend themselves in unfruitful hair-splitting and gnat-straining, the modern natural scientists unroll before you a wonderful problem of knowledge, the second greatest problem in the entire romance of love, second only to the discovery of the act of reproduction.

PART III

THE TALE OF THE DWARFS

Verily, here we sit securely;
How it happened, is not clear.
Ask not whence we came; for surely
'Tis enough that we are here.
Unto Life's delighted dwelling
Suitable is every land;
Where a rifted rock is swelling,
Also is the Dwarf at hand.
Male and female, busy, steady,
We as models would suffice:
Who can tell if such already
Laboured so in Paradise?
Here our lot as best we measure;
And our star of fate is blest:
Mother Earth brings forth with pleasure,
In the East as in the West.

Faust, Part II

§ 1

. . . 'Twas thus through hate and love that Nature
Bloomed into God, her fairest creature.

LENAU'S *Faust*

A fairy tale. Once upon a time there was a dear fat star. The astronomers of a neighbouring region in the universe observed it long, long ago. They did not look upon it as a lone star, but as a planet in a larger federation. In very ancient documents there was still the saying that it had once been blood-red, and that the spectrum analysis had shown it to shine by its own light. But that must have been long ago. Certain it was that the very feeble light it now radiated was merely the reflection of a near star, much larger and brighter, around which the fat little planet revolved just once in a year.

Now, upon this planet there grew up a race of merry little dwarfs. No one knew where they came from. Had they tumbled down from the blue sky one day in the shape of hard, frozen mummies, in whom life was dormant as in hypnotic sleep? Or did some of the pointed, sharp-edged mountain crystals issue from the rocks, like butterflies from their chrysalises, full-fledged dwarfs with pointed caps? No one knew. But there they were.

They lived each for himself, like crabbed hermits, hunted and fished to their hearts' content, and, when occasion offered, feasted royally.

There were no schools yet where they could obtain a common education. But each dwarf owned a wonderful ring from home upon which magic runes were inscribed. The runes contained in a sense both their family chronicle and their fate in the form of fixed rules of life. The experiences of their race were entered there, everything that in a long chain of generations had proved most advantageous in the harsh struggle for existence. When life raged and fretted around them, this notebook of ancient wisdom was their abbreviated system of conduct. It told them how to meet many contingencies; it was the blessing of their fathers,

enabling them immediately to choose the best course of action in important matters without always having to make fresh trials for themselves, whether in joy or suffering. Their strength, their health were also embodied in the magic ring, their whole attitude to things, in a word, their character, the personal character of each individual.

Although the brazen ring of destiny thus immensely facilitated primitive life and gave it security, it was not without a certain element of danger. The danger was the same as that which confronts a man born of an old, noble stock, firmly entrenched in a clear long family tradition, and inheriting as a sure guide to his life a rigid, unbending character. Whatever mistakes the ancestors happened to have made, whatever diseases they may have fallen prey to, whatever the whims they may have indulged in—all went into the imperious notebook. This did not always accrue to their advance. The rigidity of character thus imposed upon them in advance sometimes proved a hindrance, made them less flexible for the young, new-fashioned demands of their own lives. Nevertheless, the advantages on the whole outweighed the disadvantages. Otherwise the invisible Fairy of Fate, who ruled quietly and without rude interference and always led them in the direction of what was ultimately the "most useful," would never have bestowed the magic ring upon them.

The most remarkable thing about our little people was this: there was neither man nor woman among them. Although their characters, bodily and mental, already displayed slight personal differences, they were completely alike as regards sex, that is to say, they were entirely devoid of those differences which mark to us the so familiar contrast between male and female. But the craziest thing of all was the way they got their children.

You have read of the wicked dwarf, Rumpelstilzkin, who in his despair caught hold of the point of his beard with one hand and his tom-toe with the other hand, and gave a mighty tug and tore himself in two. Our dwarfs are really Rumpelstilzkins with this difference, that they do not perform this feat of tearing themselves in two out of sheer chagrin and as a good way to get rid of themselves. It was for pure sport they did it, and it didn't hurt them in the least. When one of them ate so much that he got as round and fat as a ball and grew so big that it was considered indecent in

dwarf society to grow any bigger—slash!—he cut himself right through the middle and lay in two halves.

Strange to say, this cutting isn't a bit the same as if one of us were to fall under the butcher's knife. Each half remains spry and alive, and before long, after having swallowed several good meals and grown accordingly, will become a well-proportioned dwarf of exactly the same size as the old Rumpelstilzkin before splitting. And this—it is too silly for anything!—is what they call getting children. In every one of these convenient acts, there was one thing they adhered to strictly, a custom the Fairy Utility had so strongly impressed upon them that they followed it implicitly. They gave each of the two parts the ring of ancestry and fate complete. The ring, you must know, consisted of a number of hoops, each of which contained a full copy of the bequest. When the dwarfs divided, the hooped ring could easily separate into two or more rings, each of which contained the entire magic charm of the runes. The quantity of metal that went into the ring was immaterial. It was the inscription that counted. It may be that each half of the divided dwarf strengthened the gilding himself by a sort of magic galvanism, or it may be that it was even desirable to let the ring become as light as possible in the successive chain of generations, so that as time went by the family chronicle was inscribed, so to speak, on thinner and thinner paper.

However this may be, the scheme worked, and the nation of dwarfs grew and multiplied like the sand upon the seashore. Not until long afterwards did certain evils arise, which threatened to culminate in a serious crisis. It happened in this way.

At first when Rumpelstilzkin tore himself in two, one of the principal conditions was that he was to be nicely and neatly halved. Each part was to be the exact size of the other. Only thus could it have the proper strength to grow up to the full size. Now it came to pass that the Rumpelstilzkins got more and more lax and inaccurate in this part of their work. Whether some of them hadn't enough to eat and so lacked the strength to tear themselves properly, and whether others, on the contrary, had too great an abundance of food and so developed an excess of strength, suffice it to say that it so happened that sometimes too much, sometimes too little, was done in the tearing act. Some of the dwarfs tore themselves in such an indolent fashion that one piece retained, say, three-fourths of the old body, and the other got off with only one-quarter. In this

case, of course, the second piece lagged behind in its development, even though it got its ring complete, as it always did, you know. But energy of character and ancestral precepts alone were not enough to help him out of the leanness to which he had been suddenly reduced. What he wanted above all was to go to work with desperate and redoubled effort upon a "fattening cure," so as to enable him to eat up to the full original size.

But this was not the worst case by any means. As so often happens, blind zeal did even more harm than indolence. Other Rumpelstilzkins for a long time snugly sat at the fleshpots of Egypt, got themselves good and fat, and when finally they set about bringing forth children, they went at it with such energy that, instead of dividing in two they sliced themselves into four, eight, indeed, even into a dozen and many more young little Stilzkins. Here, to be sure, were children galore, but they were of such duodecimo size, so dwarfishly dwarfed that the most toothsome fleshpot was not enough to nurse them even to a half-way respectable size. Nevertheless, this miniature generation, tiny though they were, would not think of giving up the business of begetting children. The praiseworthy custom had been handed down from too many generations and had been practised for too long a time. And since Fairy Utility liked the custom, it was finally conceded that it should be embodied in the laws of the magic ring. Thus it came about that the Liliputians divided themselves even without attaining the normal size. The matter had now really reached quite a serious stage. There was danger, especially in the last case, that the whole nation of Rumpelstilzkins might physically deteriorate in the midst of plenty, in a land flowing with milk and honey, that they might actually die of emaciation before a well-spread table. For with too tiny a body the fulfilment of the ring charm would be impossible; there wouldn't be enough strength. What was to be done?

One day a funny way out was hit upon.

One of those poor decimated Stilzkins had been struggling hard for some time trying desperately to get on in the world by consuming a lot of food. It ran and ran, and ate and ate, but no morsel took effect fast enough to help. Suddenly one of those roaring little lions chanced upon another of the same ilk, one of those duodecimo-edition dwarfs that came from a wholesale splitting-up. The other fellow was in the same position as our friend; he, too, dreamed of that all-in-all morsel that at one go would bring dash and snap into

his little legs. In vain, he couldn't find it. The two looked each other up and down; each seemed to think: "That looks to be a good tidbit." See! They are really advancing upon each other. Now they take hold of each other. You think that one of them must be the stronger after all. He will kill the other dwarf and eat him up. Ugh! The cannibal! The flesh of a fellow-dwarf seems to be the last resort, the strongest elixir. He evidently believes it will give him a lift.

But what actually happens? Those dwarfs do the craziest things. The two have firmly clasped each other. But as they hold each other in intimate embrace, a new idea seems to occur to them. Why kill each other? Are they not flesh of the same flesh and blood of the same blood? Why not merge in one another amid the fulness of life? Firmly, more firmly they press each other. The two little bodies break open, one against the other, the sap of life streams from one into the other. One push more, and the two have become one. A thrill of bliss goes through them, the bliss of grand satiety. They have actually "devoured" each other, like the two lions, and not even the tails are left. But neither has felt the pangs of death. Life passed completely into life. And now, in the newly born double body, there is a double force to each former single force. To grow to the full size is now mere play. Soon it will be reached, and then there will again be the tearing of self, the getting of children, the propagation of the race of dwarfs to infinity—hurrah!

It is true that the success of such a *salto mortale* from life to life was due to a tendency in a degree peculiar to the dwarfs. But do you not graft the branches of one tree upon another so that they should grow into it alive? Does not the physician in so-called transfusion pump living blood into your veins from another human being? To cover a bare wound, does not the medical practitioner by dermoplasty simply transplant a piece of skin "alive"? You can therefore imagine the union of two lives in the land of the dwarfs.

After the thing had happened for so and so many times through similar natural opportunity, the tradition gradually spread among all the dwarfs that had a leaning to multiple division; and coalescing with fellow-dwarfs in case of excessive tininess became as fixed a custom as the general custom of getting children by division. In connection with this new custom, they learned another thing, of extreme importance.

The question must have occurred to you: What became of the magic rings of the two when they coalesced? Did they both remain in the possession of the new fusion Stilzkin? At first this was really the case; but it led to useless waste. If each new Stilzkin possessed two rings, and at every subsequent division or child-getting, each was divided in half, then, according to the old method, the two rings (not absolutely alike in their descent) each had to split in two parts. Each Stilzkin, therefore, received two rings. Now, if two such part-Stilzkins united and formed a fusion Stilzkin, then it received four rings. The next fusion Stilzkin would receive eight rings and so on. Within a few generations the Stilzkins would be dragging along a whole mountain of rings. At the same time, the matter inscribed on the rings was, at least in the main, exactly alike. The multiplication of rings was therefore useless ballast in a double sense.

So Fairy Utility simply decided that in every fusion a part of the double jewel should be thrown overboard. The simplest thing would have been to decree: "When two part-dwarfs coalesce, let one of the two whole rings be cast away as superfluous." But the question arose, which of the two? And the question had to be met for the simple reason that though the rings, originally derived from two separate individuals, were very much alike, they were not absolutely alike.

To be sure, if two Stilzkins just formed by division from the same Stilzkins, coalesced again, then it is to be assumed that their rings were as good as identical. But only "as good as." I use this qualification purposely. Take two pieces of gold fresh from the mint. They are regarded as absolutely the same. But fine, very fine differences are unavoidable. Here a bit more gloss, a bit more sharpness, there a slight angularity or projection caused by a trifling irregularity in the work of the machine. Something of that nature must surely have occurred when the rings split in the dividing process. Now, take two part-Stilzkins descended with their rings from two divisions far removed from each other. Their rings certainly cannot be assumed offhand to have been alike even in the mould in which they were cast. In general outline they were similar. Did not their wearers belong to the same race? Were they not all full-blooded Rumpelstilzkins? In character, for ex-example (to use a human comparison), in the inherited pattern of their noses or hands also prescribed by the magic ring, they surely

resembled one another from the very first. In this respect we human beings are exactly the same. But, just as among us, there was a wide margin of family differences among those descended from remote division-generations. There are various ways in which such differences may have arisen. To begin with, the first individual Stilzkins may have been different; a circumstance that would have given the more closely related family trees a different direction throughout all the parallel lines of descent. There may also have been causes of variation in the individual fortunes of the parallel series of offspring. Certain fixed results, favourable or unfavourable, may in the course of time have been produced by certain events, favourable or unfavourable, in the history of this or that family.

But, in whatever way the differences may have arisen, the ring had to reflect them, since it bore as a charm the whole history of the family. But the problem was, which of the two rings to throw overboard when two dwarfs with notoriously different rings coalesced.

Fairy Utility rendered this decision: You shall sacrifice neither entirely. Since only one can remain, cut both in half; and combine the two halves, which exactly complement each other, to form a new ring. The remaining two halves you may throw away. The charm will thus, on the whole, be complete; for are they not the halves of rings belonging to two Silzkins? This method merely does away with superfluous repetition. As to the variation resulting from this half-and-half arrangement, closely welded together as it now is, it must combine into a real new unity. Charm must fuse with charm as you, Stilzkins, fuse body with body.

The good Fairy must already have been clearly aware of what soon became perfectly evident to all when the Rumpelstilzkins began to use the method of halving their rings.

It would have been a heaven-crying misfortune had the method determined upon in the coalescing of the Stilzkins been to throw out one of the rings completely. For the very union of the inequalities of the two rings (that most intimate union made possible by the proposed welding together of the two halves) was such an unlooked for happy addition in the life of our Stilzkins that all other purposes of fusion at once dropped into the background.

As I told you, in the beginning our dwarfs lived as solitary hermits. They concerned themselves for their brothers no more than for strangers. But now, since fusion for at least the tiniest became

a question of life and death, life brought the lesson home to them that there was a difference between close relatives and strangers.

Generally the young little dwarfs from the same nest immediately dispersed without looking at each other. But when it became the fashion to coalesce, it naturally happened quite frequently that two brothers met at the critical moment and again grew together. Gradually, however, it became apparent that as a fairly general rule the growing together and the fusing of rings with one's own brother offered decidedly less favourable chances than the growing together with a complete stranger of the same nation who happened to come along.

Take the simplest example. Imagine an old dwarf proceeding to the act of division. He has received from his special line of ancestors a troublesome tendency to toothache, chartered in his fatal ring. Naturally, all his children, every part of him, also received this evil predisposition to toothache. These children coalesce. If brother coalesces with brother, then toothache returns to toothache. The principle "to remain in the family" meant likewise "to remain in all the earthly ills of the family." An inbred stock can never rid itself of the toothache. On the contrary, the inbreeding would tend to make toothache worse.

Now imagine the opposite case, the growing together of the toothache offspring with a little stranger dwarf happening by with no tendency whatever to toothache. Everything diseased in him would, as it were, be attenuated through the admixture of new health. His ring of fate, which as regards toothache was the ring of his misfortune, would be reduced to half its strength; and it is in its reduced force that the children of his own splitting-up would inherit it. If his children in turn united with a stranger dwarf with a "pure ring," entirely free from the evil disposition to toothaches, then the unfortunate portion would be reduced to a quarter. And so forth. In the ever new succession of generations, through the perpetual "freshening-up with healthy blood," the little drop of disease would become more and more homœpathic, like a drop of brandy into which you gradually pour a sea of pure water, until finally its effect disappeared entirely. Of course, some dwarfs might have met with hard luck. The offspring of a family suffering from toothache might accidentally have hit upon a candidate for toothache from another line of dwarfs. But such a contingency was highly improbable, incomparably more so than among brothers of the same family.

An advantage such as this in the case of the toothache is only a negative one. Now, consider the promise of positive progress held out by the possibility of intermingling the experiences of different families and combining their wealth and many-sidedness. Through the fusion of the halves of the rings, the rigid character of the individual was enabled to freshen up anew, to become more flexible and more educable. Such an advantage of first magnitude, which not only gave the fusion dwarf a larger body, but under certain circumstances made it freer, richer in its heritage and in its character, more susceptible to development, in short, made it intrinsically a new being—such an advantage could not in the long run be disregarded. To the simple custom of fusing was added another custom: the little dwarfs avoided their own brothers as much as possible and for the purpose of coalescing chose strangers in preference.

This gave rise to a new situation. The little decimated dwarfs from the same hatchery got more and more into the habit of roaming. As they looked very much alike, it was desperately hard to tell on the spur of the moment whether the one you met was a brother or a stranger. But at a distance, far from all brothers, this danger was almost entirely eliminated. So forth they went, roaming and wandering. The habit of wandering soon began to serve a purpose in life. It was no mere whim. The little Stilzkins gradually grew to be such skilled tourists that with their brisk step they could scarcely be recognized as the dwarfs of old. It was not long before their habit of wandering resulted in a new stage of progress.

Now, you will remember that beside the duodecimo dwarfs produced by the wholesale splitting up of an old Rumpelstilzkin into twelve or more parts, I mentioned other Rumpelstilzkins, those who split into two parts of unequal size. There were many of this variety, too, inhabiting the regions of the dwarf country. I told you that the smaller dwarfs among them also had a hard struggle trying to gorge to the normal size. But they had not yet fully adopted the fashion of coalescing. An uneven little Stilzkin from twofold division was a giant in comparison with the dozenlots or scorelets from wholesale division; and to it the method of fusion was not an absolute necessity. In fact, it often led to harm, when two Stilzkins of too large a size grew together and shot up away above the normal. In brief, this class of dwarfs, though on principle not exactly averse to fusion, did not seek it. Since, in the absence of brothers of the same size, mixing with brothers was not practised

among them, they were on the whole much less inclined to wandering, remained more closely to one spot, and played a patiently waiting, rather than an active, rôle.

Now it came about that some of the wandering duodecimo dwarfs chanced upon these relatively large settled dwarfs. Ha, ha, what a delectable dish! Strangers, no doubt of it—so immensely bigger, so easily to be distinguished from the errant, wandering kind in their large ways in general. The question is only, will this stout fellow be willing? Why, yes, he actually is. The very thing he needs is a little addition to make up his full size; and here, as if from heaven, comes this little stranger, this little dwarf with just enough bulk to make up his own deficiency, no more, no less. Open arms—bing!—they fuse together. Result: a most exquisite dwarf.

That was a lucky encounter for both, a great discovery which must be exploited. A new parole seemed to have been given out—seek nobody but those large, indolent dwarfs; no more fusing with brothers; and, furthermore, no more indiscriminate fusing with any stranger abroad; join none but those inert dwarfs different from you in appearance; choose them as partners; they are undoubtedly your "opposites."

In time, the two parties grew so accustomed to each other that it became a matter of course for them to meet and unite. The large dwarfs expected the coming of the small dwarfs and the small ones counted upon finding the large. Now at last the fate of the little dwarfs, even of the tiniest, was secure. Occasionally, without fear of harm they could permit themselves to become even smaller. The large partners would help them out with their permanently ample size. Oh joy! All now went as smoothly as on wheels. It is true, the old simple business of child-getting had become a complicated matter. It was no longer simply eat, drink, and split yourself. To the old precept of growth was added: Seek a mate somewhat different in kind from yourself, or wait and hope until a wandering mate will come to you. Then give yourself to him, and merge in him entirely. From the union will spring the complete being, which will again multiply by division. Yet, what beauty, what security the added complications imparted to life! Formerly, a dwarf's entire existence, from birth to splitting-up, consisted essentially of just commonplace eating. Now was joined the whole romance of seeking, hoping, waiting, and fulfilment; the blissful self-dissolution and merging in each other, the duality of mutual discovery instead of

the former duality or multiplicity of merely the final separation. When, according to traditional usage, the time came for the merry little wandering folk to visit the stout stay-at-home dwarfs, they found that the hosts had anticipated their coming and made all possible preparations. If they felt that their own bodies were somewhat too large and fat to bear the addition of a wandering dwarf, they quickly split off a piece of themselves just before the gate closed. At times the split-off piece was so small that it was unable to live independently. It merely served as a "Karlsbad Cure" to reduce the fat sufficiently to make room for a wandering little dwarf. A similar mode of separation was used to get rid in advance of the superfluous half of the ring. As for the wandering little folk, it was known that they, too, before their arrival had rid themselves of their ballast and brought along only their corresponding half. Thus, the entire act was made to work more smoothly.

This condition constituted, as it were, a climax. In principle, it could henceforth never disappear nor be exceeded. Later additions were only in the nature of externals. They were the following.

The first question that must have arisen in your mind is, "How did the dwarfs that were the outcome of the union between the little wandering dwarfs and the large, settled dwarfs divide themselves?" You saw that the wandering dwarf owed his existence to the division of a dwarf into twelve or twenty or even more equal parts. The stay-at-home dwarf, on the other hand, owed his existence to division into only two parts. Well, this matter, too, soon regulated itself in a perfectly satisfactory way.

According to certain conditions alternately predominating pretty much in conformity with the requirements of dwarf life, the newborn of the race followed now the one, now the other method of division. All in all, there were now as many dwarfs with twofold and manifold division as were necessary to secure the continued existence of both groups.

In only one respect was there an entirely new addition. You remember that those dwarfs who propagated their kind by unequal division originally separated into a large, a mother piece, so to say, and into a smaller, a daughter piece. This method of "inequality" in division now gradually came to be adopted by all the offspring, even those who split up not only in two, but in twelve and twenty pieces. Among the latter, the division generally occurred in this way. As before, the old dwarf split off a number of small parts, but

he left behind a larger part, which constituted the principal, unequal mass. Thus, henceforth there was on the one hand twofold division into a larger and a smaller part, and on the other hand division, let us say, into twenty parts, one large piece and nineteen small ones. Both the principal parts were large enough to grow up to full size by simple feeding without coalescing. In each case they at first remained where they were. It was only the nineteen tiny dwarfs who migrated, one of them finally reaching the stouter dwarf, the smaller product of the twofold division, to unite with him in happy coalescence.

Later, a very natural improvement was introduced. The great dwarf no longer permitted the sprightly band of nineteen little dwarfs to go off by themselves and try their fortunes on their own hook. He joined the whole colony himself and went travelling along with them. He looked for a dwarf of the other kind in the act of unequal twofold division, and edging up close to this dwarf, he quickly let go one or several of his nineteen little dwarfs, let them dart across. The one he released, or, if there were several, the sprightliest of the several, thereupon fused together with the part-dwarf just detaching himself.

In point of security the method was no doubt an improvement. At the same time, it indicated a change in the entire conduct of the dwarfs, which promised to become of far-reaching significance. Fusion had broken through the spell of the dwarfs' surly, recluse existence. Now it seemed to be bearing further fruit. In that company of nineteen wandering dwarfs and one larger dwarf, something like a closer social union was bound to develop, a higher fraternity, in which one member occupied the position of a kind of chieftain. A correspondingly closer union was bound to grow up between two stout waiting dwarfs. Furthermore, the new condition would naturally lead to a more special relationship between the chieftain dwarf and the larger waiting dwarf, who mutually conveyed their wards to each other. It is true, they themselves did not coalesce. But the fact that the others did, made a certain approach to each other desirable or necessary. A bond of sympathy would naturally arise between them, bringing about this approach, while the little wards who did the actual coalescing would not need to know or to find each other except at the very last moment. Marvellous innovations, well calculated to build up an entirely new world in this land of the dwarfs.

But let us pause here. Impress the last picture sharply on your mind. Two dwarfs. One splits off nineteen extremely tiny dwarfs, the other only one, but a fairly large one. The first dwarf moves to the second, and on coming very close, lets at least one of the nineteen mites go for the split-off youth of the other. From the combination of the two young ones, arises a new dwarf of neither the first nor the second kind.

Set the fairy-tale spectacles aside. What did you see? Once upon a time there was—? Yes, but where?

The dwarfs actually form a race teeming everywhere on earth. They are the one-celled primitive beings, neither animal nor plant—not yet animal or plant. They are indeed dwarfs, mostly of the tiniest dimensions compared to you, a highly developed animal, or to a fish or an oyster or to a potato plant. Land, air and sea are everywhere full of them, although, as a rule, they are so minute that you cannot see them with the naked eye. For the sake of simplicity, let us again use the word bacilli. As I have said, we are really dealing with a whole world of organisms. Despite their exceedingly simple structure (but one cell, a single organic brick, constitutes the entire body), these beings exhibit certain difference among one another, especially in their mode of life. Some feed like plants (which may have evolved from this variety) directly on inorganic substances. Others live exclusively on this variety of bacilli, that is, they act like the animals evolved from them, who cannot directly digest certain elementary substances, but require other animals and especially plants for their nutrition. There are even various differences in structure among them, primitive though their structure as a whole is. Likewise, there are differences in their behaviour. You are looking into a huge kingdom embracing the entire earth, like the plant and the animal kingdoms, which, as I have already said, merely represent two branches of the great, original third kingdom. The two branches have risen in the scale of evolution, whereas the bulk of the unicellular creatures inhabiting the earth have to this day remained in their old original state.

You, who call yourself the lord of the earth, constantly come across these omnipresent dwarfs. You cannot take a breath of air, or a sip of water without breathing in or swallowing bacilli. Woe to you if there be antagonism between the cells of your body and a horde of those one-celled invaders! The dwarfs as cholera bacilli

mow you human beings down like yellow wheat. With no other creatures on earth, not with the tiger or the venomous snake or the deadly nightshade, does civilized man wage war so fierce and of such doubtful issue as with these primitive dwarfs of the single cell. On the other hand, all human civilization, with its agriculture and manufactures, would be practically impossible without the aid of those useful dwarfs to whom we owe most important processes of decomposition and fermentation. Wherever you turn you find yourself interwoven and intertwined in the net and in the work of these children of the third kingdom, from your conception in the female body, when spermatozoon and egg, two free "one-celled beings," seem to originate again within a higher organism in order to produce you, down to your death, when one-celled bacteria begin the decomposition that restores your body substances to the great circulation of nature.

But it is not alone because these primitive cells are so "actual" to us that they stir our highest interest. They are more. They are to this day, in the sense intimated above, the images of our oldest ancestors on earth, either not modified at all, or but slightly so.

Whether, through the uninterrupted succession of life, they are the direct unmodified descendants of the first generation on earth, as the plants and animals are its indirect and modified descendants; or whether they still originate by the millions according to the old model, through continuous spontaneous generation; or whether, as some investigators conjecture (this is still a very obscure province), certain forms revert to the one-celled stage, disintegrating from many-celled combinations; in any event, they are the portraits of our oldest forefathers. Their habits of life reproduce before our eyes what may have been, more or less, the habits of life among those organisms.

Their love, too, therefore, is a phantom picture, the projected light of terrestrial "primitive love" which has at last reached our vision.

It is interesting to note that this "love" exhibits a whole variety of activities, of different methods, attempts and variants, as it were, with apparently little order, confused and higgledy-piggledy. But if you look more sharply, an idea occurs to you. Perhaps the many outwardly trivial variants of primitive cell-love are highly significant, like all the reminiscences, however scattered, of a definite fixed line of past evolution, the first line of evolution within love.

Involuntarily, you set about trying to restore order. Here is a one-celled organism that seems to have preserved a certain stage in its memory and still persistently represents it in its mode of love; here is another one-celled organism that seems to have preserved another stage in its memory; here is a third that has preserved a third stage, and so on. Is it not possible to trace back a whole logical chain?

One capital fact strikes you. In the various love methods of the present unicellular beings, all the planks and wreckages seem in a way to be drifting around at least one great ancient bridge, the bridge leading from the very simplest mode of propagation to sexual generation. In the higher animals and plants (the best example is yourself), you see this mode of sexual reproduction working smoothly everywhere. In the lower animals and plants it is still, as it were, imperfect, clumsy and lumbering. It seems, however, that the one-celled creatures once directly discovered the road that led to sexual reproduction.

Substitute cells, one-celled beings, for dwarfs, and you will understand my fairy tale.

It is nothing but an attempt to give you a picture of that road. If you are satisfied not to weigh your every word on a golden scale, you may imagine that the course of things was actually as represented. For you can still find all the parallel instances scattered like solitary bits of wreckage among the one-celled creatures now existing on earth.

It may not be superfluous to add, although it really ought to be self-evident, that when I use anthropomorphic attributes, as though everything was done with shrewd deliberation and according to the well-considered regulations of a properly conducted police department, I am only adopting a fairy-tale form. Objectively, you may imagine the ways of Fairy Utility as Darwinistically as you please, with natural selection and the survival of the fittest; and in so far as your subjective hopes in this matter are concerned, I leave you perfectly free play. This I should like to apply to other parts of our talks. When, for the sake of vividness, I personify, when I say the animals wanted this or that in their evolution, they decided so and so, they invented one thing or another, it is merely a mode of speech for the purpose of giving the historic processes a face, a gesture. But unless I expressly speak of the problem itself, it is not to be assumed that I necessarily pronounce an opinion upon the real

source to which evolution has been traced. All the real explanations of the deeper course of evolution may be fitted into the symbolic form, all those modern theories which are represented in the works of keen men of science and are matters of open discussion.

But to come to the subject. From the very beginning our dwarfs appear as individualized, as a multiplicity of single beings. Thus, we must imagine the single-celled beings of primitive times with which life in our sense began, and thus they still manifest themselves in teeming myriads on earth. Neither theory nor practice, neither the past nor the present, warrants us in assuming a uniform "primitive slime," from which those firstlings of life could have originated. But if ever such a primitive slime did exist, it must have been prior to the time of all genuine "love."

Now, every dwarf as an individual has his "ring," which is his book of fate and his ancestral chronicle. By this ring, as you must have remarked long ago, is meant merely a certain stock of that highly precious hereditary substance which we previously discussed in connection with the egg-cell and the sperm-cell. Buried in this substance are actually the whole life of the ancestors, the heritage they bequeathed, their experiences and the lessons derived from them. It alone insures the new individual against the necessity in each instance of beginning all over again. There is no doubt whatever that the unit cells of the third kingdom already possessed such hereditary substance and that it constitutes their fixed legal code. The fact is easily substantiated by the material we have at hand. There are, for instance, single-celled creatures, which swim about generally in the ocean and are called radiolaria. Most of them are able to fabricate from the gelatinous mass of their bodies highly artistic hard silicious shells or skeletons. Some four to five thousand different forms of the daintiest design have been counted, stars, crosses, latticed balls, and so forth. But of all the radiolaria, each individual within a group reproduces just one particular design of the several thousand. One reproduces the star, another the latticed ball, etc. Surely there must be a fixed tradition here, a model, which, to speak humanly again, is perpetually handed down to the children and grandchildren.

We are actually able to determine the place where the cell-dwarf wears his important "ring." In our egg-cell it was the nucleus where the mysterious net uncoiled which later gave rise to the chro-

mosomes, the little bodies containing the hereditary material. The unit specks of the third kingdom also possess a nucleus. It has long been a disputed point whether a nucleus was to be found in all the single cells. To-day the balance of opinion inclines in favour of such an assumption, although in many cases the nucleus is scarcely discernible. Since the discovery of the significance of the nucleus as the meeting place for the chromosomes, there are also good theoretic grounds for the assumption. If the nucleus is the "ring" in our story, then the chromosomes it contains are the magic "runes" of the ring. "Magic" is a word adequately expressing our ignorance of the intrinsic character of the chromosomes and their mode of action in the cell. A thick veil of mystery still hangs over even the most careful investigations into heredity and the mechanism by which it works. All I can do is mark the symbolic story with a sign that fairy tales use for the inexpressible and the indescribable.

But now to the love of our dwarfs.

When in the beginning the dwarfs were living in isolation, they were absolutely sexless. They were neither men nor women. This condition is still exhibited by countless unit cells. Its wide prevalence, in fact, forms an important characteristic of the whole third kingdom. You look in vain for "man or woman" among the minute formless specks of slimy matter in the mud of our ponds, the so-called amœbas, or among the celebrated genuine bacilli themselves. Nor are they so-called hermaphrodites, uniting both the sexual parts in the same body. No, they have no sexual parts at all. They are all alike, and although they "get children," they can do so without any trace or possibility of sexual union, that is, they get them in precisely the same way the dwarfs do.

They possess the ability to take into themselves certain foreign substances and change them, work them up completely into their own life substance. This reception and conversion of food is necessary for so-called "metabolism," apparently a fundamental phenomenon of all life. In the process of life, the old constituent parts of the body are constantly rendered useless and must be excreted, and the excreted parts must be renewed. This is accomplished by eating and digesting. Just as we men, the highest animals, are doing now, so the unit firstlings of life did in the remote past, and so they are still doing to-day. They eat, digest and preserve themselves; they perpetually replenish themselves by metabolism.

But that is not all they do. A child in eating does not merely re-

plenish itself. It positively adds to its body, it grows. Similarly with the single-celled primitive being, the "dwarf," he, too, takes nourishment in excess, becomes positively larger; he grows.

When he has reached a certain size, his growth seems to liberate a peculiar force in the little organism. The speck of life splits up, divides into two parts, that is, it "gets children," it falls apart in two children. Apparently this capacity is as intrinsic a necessity and as fundamental a property of unicellular life as eating and growing; it must be based upon fundamental forces of this life, forces whose nature we have not yet been able to discover, but whose existence must be assumed to be an absolute fact. In a certain sense, it seems, the "falling apart," the simplest form of propagation, is the positive continuation of the process of excretion in metabolism, corresponding to the positive continuation of the restorative reception of food in growth. Be this as it may, the fact itself is beyond question. A unit amœba to-day gives you a plain picture of the process. After its soft slimy body has reached a certain size, instead of growing further, it simply contracts in the middle; the indentation on each side grows deeper and deeper; but a thin thread of living substance still holds the two parts together; and now you see two creatures instead of one, each half the size of the old amœba, but each a new separate individual, ready by feeding and growing to work its way up to the former size and then divide again. Among the bacilli the whole process, growth, division, growth of the parts and redivision of the parts, often takes place with such singular rapidity that in a few hours, nay, in a fraction of an hour, the generations rush forth from each other as from under the knife of a machine rotating with dizzy swiftness. If there were no natural hindrances in the way of this wave of propagation, as convenient as it is rapid, a single bacillus culture would in a few days fill up all the oceans and pile into towering mountains—a formidable, uncanny love activity smacking of that crudely gigantic, demoniacal force which is characteristic of all the natural manifestations in the kingdom of this seemingly tiniest dwarf.

Only one thing is absolutely essential in all these divisions. The "ring" with the sacred family runes must in every instance go into both or all the divided parts. He who did not get it would be a poor shipwrecked dwarf, deprived of the help of communication with the world from which he comes. As a radiolarian he would be unable to construct his skeleton, as an amœba he would be unable to crawl, to

appropriate the right kind of food, to fulfil the work of life of the particular community to which he belongs. He would not possess all those protective reactions which his ancestors have bent their energies upon in the course of many generations as the best for their environment. The ring with its hereditary runes is indeed the nucleus full of the chromosome substance. Hence, in division, this nucleus must also divide, or, better, it must double itself in its full force. In the egg-cell we saw how at the moment of division it doubled its chromosomes, how it made, as it were, a copy, a duplicate equivalent to the full value, of each hereditary little body. That is what is meant by the splitting-off of the second "ring."

We will proceed with our story. The dwarfs fell into habits of division deviating from the normal. One dwarf would split off from himself not a half, but a much smaller piece; another dwarf would break up into a number of tiny parts. Examples of both methods are still to be found in the unit cells of to-day.

Among a large number of infusorians, a group of beings also entirely belonging to the one-celled kingdom, you see genuine division in half replaced by the simplest form of so-called "budding" or "gemmation." Instead of dividing into two equal halves, the infusorian separates from its main body only a small, secondary part, like a bud. The process is still division into two parts, though the parts are very unequal in size.

On the other hand, in a still larger number of unicellar beings, you find cleavage into two completely abandoned in favour of the breaking-up of the parent body into a whole mass of independent parts. In its more developed, generally somewhat modified form, this method is called "spore-formation" or "sporulation." The cell-body of the primitive being bursts, as it were, into a little dust cloud of swarming Lilliputian cells ("spores"), each now representing a new, independent individual. Some infusiorians separate into two hundred and fifty or more spore-children. In essence, however, this method is still the same as that of the second case among the dwarfs. Our duodecimo dwarfs, grown too tiny and feeble, were in danger of dying out, when at the last moment deliverance came through the coalescing of two of them.

Well, the essence of the fusion of the two one-celled individuals you can still study very conveniently in the innumerable representatives of the third kingdom, to wit, the conjugatæ, rhizopods, spo-

rozoa, flagellate and ciliated infusorians, and others. The more study that scientists have given the life of these strange creatures, the more evident it has become in recent times that, in addition to simple division or fission, fusion is also to be found throughout the kingdom to a much larger extent than biologists had dared to suppose. And we cannot fail to recognize that in a large number of such cases the original purpose of this strange act of fusion is to stimulate the growth and increase the size of the body. Some of these queer saints, indeed, seem to have made it a fixed habit always to raise the danger of progressive reduction to the very highest point, and then, in turn, as if by a preconcerted plan, to bring into play according to programme the rescue of fusion. They divide until the size of each part is reduced to the minimum, then bring about the fusion of two individuals, and thus again insure new rapid growth and new energy to their entire race.

You can observe a neat example of this process in some of the diatoms, unicellular beings that feed like plants. Each diatom of this variety has its soft cell-substance encased in a movable, flinty shell. The shell is composed of two valves which form a regular pill-box, one round valve fitting like a lid over the other smaller one. In dividing, one child gets the larger part of the box, the lid, the other, the bottom. It is true that both soon complete their shells, but each builds only a bottom to his box. The smaller shoot uses his bottom as a lid and adds a still smaller under part. Naturally, number two will eventually have a smaller box fitting a smaller cell-body. Upon further division, not only will both children in the next generation be smaller than the common grandfather, but the one that receives the lesser value will be tiny in comparison. Now, imagine this to continue for some time. In one line the boxes will get smaller and smaller, dwindling to baby pill-boxes and dwarf cases and finally to such Lilliputian capsules that no normal cell can live in them. In this event the two inmates of these extremely contracted quarters simply shake off their encasements, and, as they thus strip themselves naked, they coalesce. In this way they attain tolerable size, and the enlarged fused individual again constructs a whole box of average dimensions for itself.

I think on the whole it is reasonable to assume that the first tendencies to regular fusion are to be traced to some such extremely simple causes as these. It was originally a way out in an emergency, and for a long time it may have taken place only occasionally.

Then, as often happens in nature, through the unexpected co-operation and intervention of other agencies, something tremendous was evolved from this little matter. It was evolved through the deepening of that merely external process which appeared for the first time in the fusion of the exceedingly minute specks of divided cells.

For of this there can be no doubt, that with the first fusion of the two cell-individuals into a third, new individual resulting from the union of the two, a new stage of love-life in nature was presented as a possibility. This means conjugation, as it is called, of two similar young cells means, strictly speaking, the first tendency to sexual love, and hence to love in general in the narrower sense. Bear in mind, in outward form there are still no "sexes" in existence. The two coalescing beings are absolutely the same in appearance. This similarity of structure in the simplest form of fusion is still found in a number of instances in forms of life even higher than the one-celled beings. You know that the plants and animals have evolved from the third, one-celled kingdom. Well, even in real plants of the lowest order, you find the same sort of conjugation as that of the similarly formed tiny unit cells. There are the fine emerald-green algæ threads on the pebbles of brooks and in fountain basins. Algæ are the lowest forms of plants. Every thread consists of a loose line of cells. In due time the cells separate, each for itself, and each divides interiorly into a whole colony, a whole swarm of pygmy cells. Active as they are, they instantly dart into the water. If two cells from different colonies, yet absolutely alike in external appearance, meet, they do not avoid each other; on the contrary, they rush to each other, as if seized by a sudden sympathy, draw tight together and, finally, with a last push, coalesce in one body. So it is among genuine algæ of to-day. Why, in a logic of things so extraordinary, should it not also have been the general way in the earliest times, the way that led to fusion on the whole, and thus into the line of sexual generation?

Of course, this leaves certain mysteries unexplained. But mysteries reside in the heart of all vital phenomena. How, indeed, can two individuals, each a being in himself, whether small or large, whether similar or dissimilar, flow into each other? What "sympathy" is suddenly set at work to drive the living cells together, like the atoms of two elements in the formation of a compound? We do not know. But understand; neither do we know intrinsically why

metabolism must take place in the cell, nor why there are excretion and repair, feeding and its opposite, growth and fission. Here, too, in this most primitive process of the living fusion of two cells, as exhibited in the diatoms, we get the general impression that originally it was but a positive continuation or modification of one of the other processes. I have already told you that the simplest events in cell-life apparently depend upon simple metabolism. They are: reception of food (feeding) for the purpose of renewing those parts of the cell-substance which have been rendered useless, and elimination or execretion for the purpose of removing this waste as well as those parts which have been taken into the cell but cannot be worked up into the cell-substance. Then there is growth, a positive extension of the simple process of repair. Growth, in its turn, seems to give rise to a sort of positive form of higher, living excretion—propagation through fission or gemmation. Now you can without difficulty go a step further and say that, just as simple feeding must constantly make good the loss of excretion, so in certain circumstances a new special kind of feeding must make good the loss produced by a too active excretion in propagation. But since propagation is a living kind of excretion, the feeding must in this case be a living kind of feeding, that is to say, living substance as such must flow into the living cell. To express it very crudely, the process of getting children is merely a higher form of eliminating an excrement; and love by the fusion of two individuals for the purpose of producing a third is merely a refined form of feeding. You understand in what sense this is meant. It is no paradoxical jest; it is a serious, sober idea. Yet, neither at the beginning nor at the end, neither in the "simple" nor in the "refined" process, does this explanation enable us to see the things clear through to the bottom. Feeding and excretion are at heart as deep and lofty riddles of life as propagation and love. One fact alone seems to come out clearly, that the concepts of propagation and love are secondary concepts; they represent higher rungs on the ladder of evolution.

The very next step in our story shows, if our comparison be valid, how love, the "living kind of feeding," was immediately so enhanced, even in the one-celled beings, that something quite new sprang up as a result. Savage nations still believe that in drinking the blood of a lion something of his character, his courage and his power passes into the man who drinks it. Itself a myth, it yet applies most truly

to the manner in which our dwarfs perpetuate themselves. Simple fusion for promoting growth soon developed into real "character feeding." It was thus that a higher connection was established through fusion.

Among our dwarfs the question arose, when two individuals join, what is to become of the two rings? Translated into the true cell-language of the third kingdom, this question reads, When two cells unite, what is to become of the chromosomes of the two cell-nuclei? The chromosomes contained hereditary material enough for two individuals. What arrangement is to be made if henceforth only one individual is to exist?

Recall the egg in its dark shaft. Before it fused with the second cell, the sperm-cell, it threw overboard, in the so-called "polar globule," half its chromosomes, that is to say, half its "ring." The spermatozoon, the sperm-cell, had previously done the same. Thus arose a new fused cell which, though a combination of two cells, possessed only a single individual's normal number of chromosomes, a half-and-half mixture of the amount in the two original cells. This is exactly the method followed by our dwarfs in the story of the two half-rings.

As a matter of fact, these "birth processes" can still be observed side by side in all the various stages. There are one-celled beings in which the nuclei in the fused individual still remain unfused. In these, therefore, both the "magic rings" are preserved. On the other hand, there are one-celled beings, for example, the sun-animalcule, a fresh-water rhizopod, in which we find the completely developed stage. In the sun-animalcules, before the complete coalescence, "a polar globule" is extruded from each of the fused individuals, just as in the egg, whereupon follows the complete coalescence of the nuclei. With these "polar globules" the "half-rings," that is, the half of the chromosome property, are simply flung overboard; and in a newly born, genuine fusion nucleus, the new unit individual again crowns itself with a single "ring" formed of the remaining halves of the ring. The remaining halves of the chromosomes in the new nucleus form a new simple chromosome capital. The investigations of this difficult subject in our single-celled beings have not yet been carried far enough to enable us to tell with certainty how general this stage is in the large bulk of organisms already practising conjugation. But the probability is, that this achievement spreads over a large area.

Superficially, it may appear that this wise regulation is only a secondary matter, a mere form. It simply saves a useless excess of chromosomes. But mark you well, it saves something more besides. If both the "rings," both chromosome portions of the original fusion cell, are lugged along separately, and if, when the unit cell in its turn divides, each is again transmitted by itself to the grandchildren, no real chromosome fusion takes place in any cell. No two masses of hereditary substance really ever "cross" for the production of a new unity of different hereditary parts. But with the growing together of the two "half rings," this innermost mixture is affected in the most acceptable and most adequate form. Hereafter all grandchildren and great-grandchildren to the remotest generation will perpetually inherit the mixed hereditary mass from the new ring. Character and Book of Fate of originally two individuals entered into it half and half in harmonious combination. What that signifies is told in the story of the dwarfs.

For utilitarian reasons the dwarfs accustomed themselves not to fuse any more with their direct consanguineous brothers, but with members of foreign tribes. That gave them an advantage superior to any that fusion had hitherto brought; in fact, it ushered in a new era among them.

In the true story of the cellular beings, this paragraph reads thus: With the simple fact of the union of two cell-individuals into a unit third is combined one of the greatest problems of cell-life and love-life in general, the problem of crossing and inbreeding.

§ 2

Through the whole of love-life in nature runs a law of tremendous import. When man awoke, when he converted his obscure impulses into moral codes, this law was the first that he wrote down. But long before him it had already existed as an iron commandment of nature. He himself would never have come into the world had it not enforced its authority without any writing or tablets.

It condemns inbreeding. Thou shalt not beget children with thy father or thy mother, thy son or thy daughter, thy brother or thy sister. The child born of such a union is a child accursed. For it is a child of inbreeding, of the union of blood with blood too close akin.

This cry, this curse, began deep down in the kingdom of the living.

It sounds in the Bible of nature, which is countless millions of years older than the human Bible, the human moral code.

Look once more at the little green algæ threads, lowest of plants, which, though somewhat advanced beyond the stage of the one-celled firstlings of life, still exhibit the simplest form of fusion, with the two uniting parts alike. See the two tiny fractions of algæ moving about in the water and looking for partners to combine with. They are genuine brothers from the same divided cell. They meet, but they avoid each other, as if driven apart by a sudden antipathy, as imperious as the force of electrical repulsion. The next moment, however, they have each come across a stranger, a swarm-cell, who is not a brother. Straightway, with the most vehement intensity they unite. Why does brother scorn brother?

Look at another picture, at the higher plants. Here is already genuine sex-division. The flower has a female part, the pistil, containing the ovary, and a male part, the stamens, containing the pollen. But that only by the way. What we are concerned with is that in a vast number of cases, both parts, where a mixture of fusion occurs in the sexual act, are found close together in the same flower. These higher plants no longer send off motile swarm-cells, as do the algæ. What an extremely happy arrangement it seems to be—does

it not?—to have both the sexual parts united in the same flower? The stamens, you think, need only throw off their pollen at the proper time to fall upon the stigma and fertilize the ovules by fusion.

Far from it. In ninety-nine cases out of a hundred you find the most ingenious devices to prevent this fusion of the cells, this "be-getting" or breeding within the same flower. In numberless instances the whole flower is so contrived as to make self-fertilization impossible, despite the very close proximity. On the other hand, though itself stationary, the flower is most aptly devised to invite visitors, certain insects that flit about from flower to flower, hornets, bumblebees, flies, butterflies. The plant attracts them with all sorts of colours and odours and fountains of honey. In order to get at the honey they must crawl into the flower or must reach down into it with their proboscis. As they do so, it powders them with its pollen-grains, which are its sperm-cells. Alighting on another flower of the same species, the insect naturally, without any conscious effort of its own, sticks the pollen on the flower's female sexual organs (the stigma and the ovary), and thus brings about cross-fertilization, apparently a very important, in fact, an indispensable condition to the life of the plant. Thus, you find here the same case, though infinitely more complicated, as in the lowest plants. The brother sperm of one's own flower is anxiously avoided; on the other hand, the foreign sperm that the insect conveys is a most welcome friend to fuse with. I will give you a still more detailed instance, since the subject is interesting from whatever angle it is approached.

From the herbage under the olive-tree pluck one of those rare, pale-green stalks in which a large leaf seems to be folded around the flowers like a furled flag. It is one of the so-called wake-robins of the family Araceæ. Snap the stalk, see where it is coiled tightly, as in a pot. When you split up its wall, a whole swarm of extremely small black gnats rush out, as if suddenly liberated from prison. How did they get there? You have before you the most wonderful mechanism of the whole plant world, a mechanism for cross-fertilization, for the prevention of inbreeding.

The wake-robin exhales a rank smell, which attracts the little dung-flies. They crawl into the open green tube from the top. There they encounter a stout pole protruding from the middle of the little pot. The pole is the tip of the flower (or here, rather, the

colony of flowers). The insects scramble down the pole and reach the pot. It's a delightful place for them to be in. While outside the cool dew is falling, the plant within develops the most comfortable temperature. The inner walls of the pot actually flow with juice, a most abundant repast. But what is this? A little fly, having warmed itself through and through and eaten to its heart's content, wants to leave the hospitable shelter. But it cannot, and it discovers that the whole gourmandizing company is imprisoned in the pot. In entering they carelessly crossed a wreath of pliant bristles; and now when they want to leave, the bristles ruthlessly bar their way, like a fish-basket or a mouse-trap. What is to be done? For a few days the little prisoners swarm restlessly about in their prison. But all the time they are kept well fed and warm. In the meanwhile, something strange is happening in the plant. The flies at first probably pay no attention to it, since it doesn't seem to concern them at all. Pressed close against each other on the pole is a row first of male sexual blossoms, then female. In this most dangerous contiguity, one on top of the other, you would suppose that it would be the easiest thing in the world for them to mix, and that the swarming of the flies was the very thing for facilitating the intermingling. But that would mean marriage in one's own family, which the plant absolutely does not want. So what does it do? The two rows of blossoms do not mature simultaneously, but first the female, and then the male. While the prisoners are still fidgeting about, the males reach sexual maturity and suddenly discharge thick masses of "pollen," the genuine, male fecundating element of the plant. The flies are powdered with the pollen dust, but take no notice of it. Something of far more importance to them engages their attention. Fortune is smiling upon them. As if the maturation of the pollen had sapped the strength of the bristles above, they suddenly loosen and wither. The way to the sun is again free, the insects swarm forth, wild with joy. So after all, getting caught in that wake-robin does not seem to have been so serious a matter. Scarcely liberated, the same flies again yield to the temptation of the dung smell so sweet in their nostrils, and crawl down another stalk. Again a few days in the lock-up.

Now carefully observe what happens. It will be long before the male blossoms in this plant mature, while the female blossoms have turned ready for fertilization just as the visitors enter. The flies come carrying pick-a-back to these matured women blossoms the

ripe male pollen of another wake-robin. As they swarm about, they unknowingly, but quite naturally, stick it on to just the right place. Is it not a device of unparallelled ingenuity for preventing the marriage of brother and sister? In some varieties of the wake-robin, there are two fish-baskets in the pot, one at the entrance to the male blossoms, another between the male and the female blossoms. The lower basket imprisoned the gnats powdered with the pollen dust of another flower in the lower story, among the female blossoms. After they have remained there a while, they creep back and are detained in the second basket in the male zone, there to be powdered for the next flower.

The number of such cunning contrivances is legion. Where the transference of the pollen from one flower to another is not effected by insects, the wind acts as agent. On passing a hazel-bush, the spring wind has covered you from head to foot with pollen dust. In rare cases, in order to bring about cross-fertilization, some higher plants even succeed in completely overcoming their stubborn immobility. In the blue waters of Lake Garda grows the exquisite vallisneria, an aquatic plant, which never has both sexual organs combined in the same flower, and yet does not require insects for fertilization. The flower bearing the ovary alone rises from the bottom to the surface on a long scape. The other, the male flower, containing the adhesive pollen, breaks away entirely from its stem below, rises to the surface, and drifts merrily along with the waves, like a tiny raft until it finds the female flower. Then it lands and fructifies it.

Go still further—to the higher animals. Ask an experienced stock-raiser what he thinks of inbreeding. If animals, pigs, for example, of the same family, especially of the same parentage, are continually paired without the introduction of fresh blood, then, in the course of generations the most peculiar forms of degeneracy set in. The animals, both male and female, become weak, short-lived, and, finally, for the most part, sexually impotent. Every breeder knows that he must be careful, that excessive inbreeding invariably produces harm. He simply tells you, "Inbreeding is unnatural." Nature has laid a curse upon it, which leads to the ultimate extinction of the whole family.

Now turn to yourself. Would you marry your sister, your brother? The "law" in the modern civilized state strictly prohibits it. Upon what is the law based? Upon moral conceptions much

older than all our modern states, than our civilization. Savage peoples without states, without laws, and almost entirely without civilization regard intermarriage among brothers and sisters, or parents and children as impermissible as we do. Are these conceptions, which are older and more firmly established than the pyramids, religions or kingly crowns, merely a mystical human caprice? The physician, whose moral code is statistics, says, "No." By a series of figures he shows you that there is the greatest probability that inbreeding up to incest is as dangerous for men as it is for pigs. The progeny of the marriage of brothers and sisters, or of fathers and daughters, and so forth, are as degenerate among men as among pigs. So say at least an overwhelming majority of physicians. The theory does, indeed, seem to be "awfully probable" when you reflect that man is only a specific instance in the kingdom of the living and the damnation of inbreeding bursts upon it like a raging storm from all vegetable and animal life.

What does it all mean? What is the significance of nature's extreme repugnance to inbreeding? From present conditions among the higher animals and plants, it seems clear that Nature in the course of ages has put up a real bolt. In many cases, incestuous fecundation has ceased to be effective. In others, decay with impotence and the like, sets in so rapidly in the immediate offspring that the development of further consequences is impossible; justice is visited upon the transgressor at once. Swift as is this action of nature, it is only a gradually achieved result, the price of long, long experience. Thus, the young chick now develops eyes when still within the dark shell; its progenitors, however, for an interminable period of time had to experiment with the contrast between light and darkness, had to make shift as best they could, with no special organs of sight.

Countless generations of the earliest primitive organisms on earth had to have the lesson drilled into them that in the long run inbreeding is injurious, and, on the other hand, cross-fertilization, the admixture of foreign blood, is decidedly advantageous. Of course, neither must the foreign blood be too alien. A certain relationship, the relationship of species or kind, was necessary. But within the species, the mixing must take place between different families. We can fix the stage at which the organisms first began to learn their lesson. It must have been when, in the fusion of the cells, the nuclei of two individuals began to combine in the ratio of half their

chromosomes. It was the chromosome portions that first carried "blood" to "blood." The experience that family blood and family blood produced bad results, whereas foreign blood and foreign blood produced good results, could only be obtained subsequent to the coalescence of half and half the nuclear chromosomes. Unit cells of the third kingdom, like the radiolarians, in which there is already complete half-and-half mixing of the chromosomes, must have learned this lesson through their own experience, and must have been the first to cause Fairy Utility (Darwinistically, the survival of the fittest through natural selection) to intervene and lay down a law. What the grounds were on which "good" was separated from "evil," I have indicated in the story of the dwarfs, negatively by the example of the toothache, positively by that of character. Of course, the primitive cells, which may be said to have possessed no real higher organs in our sense, had no teeth and therefore could have had no toothache. But they could have had certain ills, which were transmissible as bad family qualities. "Inbreeding," it is clear, would tend to conserve family ills and render them more persistent, whereas coalescence with "foreign" portions of cells would gradually paralyze them and bring about their final disappearance. Moreover, the mixture of two individual characters into a third new character offered a positive source of infinite wealth. In the rigid monotony of the eternal repetition of the existing, it bore the possibility, of a "turn of fate," as it were; it held the grace of a new beginning, the dawn of progressive evolution. Now consider these matters, too, in a wholly human way. You have a right so to consider them because life in nature is so consistently uniform that you yourself are but a complicated primitive cell. Think what a tragedy it would be were your children in each feature of their character to be exactly like you or their mother. The thing that makes life so rich is that out of you two; nature's deep smithy forges something mysteriously new.

If in simple cell-division and in the simplest cell-fusion, love—the use of the word here is justified in the sense that these primitive processes have always played and still play a rôle in the love of all organisms, including man—if, in these simple processes, love is merely a means of maintaining the *status quo*, the primitive balance in life (a higher form of metabolism), then, with this new turn of fortune, with the mixing of two individual characters into one new character, it entered for the first time in the service of evolution. It helped the creation of the new beyond the *status quo*.

§ 3

Let us go still further. The preference for strangers for the act of fusion led the little dwarfs to go a-wandering. In their wanderings they chanced upon foreign indolent dwarfs, the product of unequal twofold division, and accustomed themselves to fuse with them in a specially advantageous way. Thus arose the distinction between the individual members who fused with each other. Duality of sex began in the sense that two sexes could now be distinguished even externally—a little, active, searching part and a larger, more passive and expectant part.

As an example, take yourself again, the most highly developed animal. Do you not see the primitive process from the fairy tale of the dwarfs, from the ancient world of simple cells trailing after you like a shadow?

To begin with, there is in man a fixed, decided distinction of form between the two individuals uniting for reproduction. Not only that brother shuns brother, that he looks for a stranger; normally he also looks for an individual markedly different from himself in bodily form. A man looks for a woman, a woman looks for a man. Now examine the distinction more closely.

Do you see the trace of the old dwarf fairy tale, the tale of the active cell that wandered about and searched, and the passive cell that sat and waited? In the tremendous whirr and bustle of modern civilization woman is everywhere, as it were, "at the wheel." She is taking part in thousands and thousands of bodily and intellectual movements. Her activity is increasing under our very eyes. It is not to be stopped. Nevertheless, hold your gaze fixed steadfastly upon sexual life, upon the sexual act itself. Here man is still the giver, woman the receiver. Turn your fancy back to that mysterious primal phenomenon of human generation. In the dark bottom of the female sexual apparatus, in the smallest, narrowest, but the most determinate element of it, you see the same contrast. The egg-cell it is true, has its own life. It breaks away from the ovary by an act of division in precisely the same way as the stationary dwarf broke away from its parent dwarf by an energetic act of motion.

It wanders through the oviduct to the womb, moving, therefore, of itself a certain distance to meet the male sperm. Movements of the nucleus take place in its own interior. The closest observer of the human egg, Nagel, saw very plainly, in a previous stage of the egg's development and within the nucleus itself, occasional manifestations of mysterious movements, like those of a crawling creature. But the stationary dwarfs of the fairy tale, stationary in only a general relative way, must also have moved about to some extent, though much less than the others. And surely there is no doubt of this, that when you see the spermatozoa penetrate into the lower opening of the oviduct and crowd about the egg, you have the distinct impression that only now has the active element, the truly motile force arrived, the force exactly corresponding to the merry itinerant pygmies of the fairy tale. Even the difference is preserved in the relative size of the spermatozoon and the ovum. One spermatozoon penetrates into the egg, and again you have the parallel in the ovum nucleus and the spermatic head. Both move, one very slowly, the other as swiftly as an arrow. Finally, the climax is reached in the fusion of the two nuclei. In this culminating act you have the same contrast here as in the one-celled beings, the contrast between mobile and immobile, between large and small, between male dwarf, male cell, and female dwarf, female cell.

The process that man thus mirrors in the most intimate reproductive act within his body may still in its complete bodily form be directly observed in a large number of extant one-celled organisms. There is a tiny green ball scarcely a millimetre thick, that is to say, about as large as a pinhead, which whirls rapidly through the water. You examine it under the microscope. It is not a single cell, not a unit one-celled being, but a cluster of cells, thousands of them attached to one another in the simplest sort of social union in the form of a movable ball. Volvox, or globe-animalcule, the investigator calls the strange thing. As a matter of fact, they are neither genuine animals nor genuine plants, but primitive organisms living together socially, to which in their origin the plants are perhaps more nearly related than the animals. For the time being, disregard the social element exhibited by these organisms. Confine yourself to the individuals of the volvox ball. See how they reproduce. As in a great many of the extant unit cells, you find all sorts of reproductive methods side by side in the different varieties of the Volvocineæ. You find simple fisson, division into many pygmy swarming cells,

and still fusion (conjugation) of perfectly equal cells. In some forms you see the beginnings of a difference between the fusing cells in that one is larger than the other. In other forms you find a sharp contrast. In one kind of volvox ball, as a matter of fact the ordinary volvox, only large, indolent, stationary cells are, for the most part, divided off; in another kind, only small, active, motile cells; and it is the small active cells that go to find the large lazy ones and unite with them.

You can very nicely observe similar processes in even somewhat more highly developed real plants. Go to the northern seashore again, and look in the washings of the tide for the common bright-green bladder-wrack (fucus), a very low plant. We have already touched upon its love-life. Among the bladder-wracks, too, there are, on the one hand, the large quietly waiting cells, and, on the other, the tiny, swarming wildly active pygmies. Among them, too, the regular custom prevails—the two distinctly different cell-types find and fuse with each other.

In this connection, it is interesting to observe with what certainty the active cells liberate in the tidal water, and, at first swarming at random, know how to discover and snatch the inert cells. It is assumed that the large inert cells impregnate all the water in their vicinity with certain substances (organic acids), which act as an exciting and attracting force upon the minute swarm-cells. The attraction of love, therefore, even in this lowest plant, is effected through sense.

In our tale I have always spoken of the dwarfs as "seeing." This was symbolic. In reference to one-celled beings or lowest plants, you must of course interpret the expression very generally. Where there were as yet no eyes, and where, at any rate, the sensation of light was not strong enough to convey to the partner an adequate picture of the second cell, the process by which one cell found another must have been largely effected through chemical excitations of smell and taste. Remember that even among higher organisms endowed with eyes, chemical excitations undoubtedly play a powerful rôle in all love matters. In some instances of low plants, naturalists have succeeded in demonstrating these enticing "egg-scents" or "egg-tastes." In ferns it is malic acid that acts as a lure to the sperm-cells. It was found that malic acid may be used to attract them artificially. A tiny pipette open at one end was filled with a 0.05 per cent solution of malic acid and placed in a drop of water

in which numerous freely moving fern sperm-cells (they are freely motile even in these plants) swarmed. The "spermatozoa" became almost instantly aware of it. They moved to the pipette and swam into the opening, as if it were a real egg-cell. In twelve minutes all of the twenty-four sperm-cells had passed through the narrow gateway into the appetizing malic acid chamber. How fine must be the sense that enabled those microscopic cells, each no more than fifteen thousandths of a millimetre long, to notice not only the generally pervading malic odour, but the direction from which it came strongest, so that following it the spermatozoa could swim up to the glass pipette with the rapidity of an arrow. An accidental discovery in the dog has established the fact that this "following of the scent" plays a part in bringing together the sperm-cell and the ovum-cell in the highest vertebrates also and therefore, no doubt, likewise in men. To find their regular meeting-place in the uterus or near its passage to the oviduct, sperm and egg in the higher vertebrates must first make their way some distance toward the uterus. It was observed under the microscope that living spermatozoa of dogs would instantly swim to a fresh piece of mucous membrane of the uterus, while they would pay no attention to corresponding pieces of liver or another organ. The uterus, as approximately the place where the male and female cells meet to fuse, must itself emit a definite sense impression of a nature calculated to allure them. You may therefore say, in the language of our fairy tale, that the dwarf that fared forth to look for a mate smelt the waiting dwarf, or tasted him by the water that he impregnated, long before he saw him.

I could cite a number of other cases to illustrate this side of the dwarf story. But in the end they all lead to the same thing. From a hundred sides and angles you see the division of the sexes marked at first by the difference in size of the two fusing cells. To this difference came difference in mobility. Our example of the dwarfs shows you in one and the same case, as it were, how the two differences might originally have developed on the simplest basis. It is important to note one thing further in this connection.

In an overwhelming number of one-celled organisms, you find developed, quite independently of propagation, a mode of life altering between the stationary and inert and the mobile and swarming; just as if the primitive beings had practised and cherished this "Either-Or" from early times to serve them for all kinds of ordinary purposes in life. Occasionally, within the same individual and

within the limit of his own life, you observe an abrupt change from stability to mobility. During digestion, when their abode dries up, for protection against all sorts of external dangers and injuries, you see the merrily, freely swarming cells suddenly settle down and encyst themselves for a rest. When the cause or the danger is past, the stationary little cell turns as cheerfully again into a swarm-cell. What wonder that this characteristic so widely spread and frequently utilized should be transferred to the sphere of love and there acquire a great, indeed, a fundamental significance? For the fusion of two cells, organisms favoured a state of stability in the one and mobility in the other. Once this condition was fixed and combined with difference in size, the result might very well be that mobility should develop into a more or less set characteristic of the one element, the male element, and stability into a more or less set characteristic of the other element, of womanhood.

At any rate a difference arose. That was the main thing. For the first time sex difference, sex distinction emerged, the distinction between man and woman, first merely in the simplest form, in the same way as in yourself the one-celled spermatozoon still represents a "man" and the egg of your wife still represents a "woman." Here you must once again thoroughly impress one thing upon your mind.

The sex difference, the distinction between man and woman, was at this its starting-point only an external means for a definite other purpose, namely, to bring about the fusion of two foreign individuals, two individuals with chromosomes as individually different as possible. As hitherto, the cardinal factor for the chromosomes was still their individual difference. Exactly half of each individuality went into the fusing, as before. This fundamental was not in the least altered by the additional factor of sex distinction, the effect of which was not such as to change the proportion of chromosomes in the act of fusion. For example, the egg-cell because of its larger size did not contribute more chromosomes (a larger piece of "ring") than the smaller sperm-cell, and so did not lend preponderance to the female sex in succeeding generations. Nor did the sperm-cell, because of the greater activity and mobility of the male element contribute the lion's share of the chromosomes, thus securing a "stronger race." Nothing of the kind. The essence of sexual love at this deepest, most decisive point was still the mixture of the fundamental substance of two individuals upon the basis of absolute equality, half

and half. We may at once add that this essential fact has never been altered a jot or tittle, even in the highest evolution of love-life in nature. Even among us, the child receives twelve chromosomes from the man and twelve chromosomes from the woman. The essential thing remains that this half-and-half portion is derived from two human individuals as far apart from each other as possible, in fact, direct opposites. That one individual is always man and the other always woman is only a superficial external mark, as it were, for telling the difference. Strictly speaking, the entire chasm between man and woman is merely nature's device for dividing off individuality from individuality as sharply as possible. But when these individualities come to mingle with each other, then each has an absolutely equal claim, and there can never be a balance in favour of the one over the other merely because one portion was contributed by a man, the other by a woman. In this sense there is no "original difference of the sexes," rising superior to the difference of the individualities and governing it. Originally personality stands above man and woman. In the very highest sexual act, in the mingling of the chromosomes, exactly two half personalities are used.

It is not superfluous to emphasize this at a time when again and again we find a tendency among us to force the inference from mere incidentals of sex distinction that woman is by nature inferior and, simply on the grounds of her sex, deny her the full wealth of personality. In order to play her up as a personality, nature has created woman like man. You know what this concept of personality signifies. It holds man's deepest mysteries, his highest endowments; it holds the possibility of genius.

The rest of the dwarf idyll follows as a very simple consequence —that you can see yourself. But at bottom there has been an enormous revolution here, too.

Our fat waiting or settled dwarfs throw overboard a last piece of their plethoric body, then also half their ring, in expectation of the wandering or swarm-dwarfs. This explains the process that every egg undergoes when it expels its two "polar globules" in the manner described above. It has already been noticed that genuine unicellular organisms also throw off little bodies before fusion. The two cases coincide in all respects.

The two dwarf parts, then, gradually fall into the same practice of dividing unequally. That is to say, in both cases each parent dwarf divides into two parts, one the larger, principal piece, the

other a much smaller piece; in the one case, the smaller pieces are minute (male) swarm-cells, in the other case, a relatively larger (female) settled dwarf. Of course, the inequality never affected the "ring" (the chromosomes), which entered into all of them complete. But there were differences in bulk. What does that mean in other words?

It means that henceforth neither man nor woman divided directly into his or her offspring; they only split off a more or less limited part of their body for their progeny. In the male, the split-off part broke up into minute swarm youngsters, in the female it formed one, and later often more than one, large inert daughter. Translated into "cell-language," two unicellular, primitive beings, a male and a female, thenceforth exercised their masculinity and femininity only by yielding up a limited piece of his or her cell-body for the purpose of reproduction; one of the cells splitting up into many male swarm-cells, the other forming one or more inert female cells.

The story of the dwarfs went on to tell, in a sort of appendix, of the way the male and the female at this stage conveyed their generative products to each other. At first they both let their little cells go according to the old custom. Then they retained them and brought them to the act of fusion by moving together as a whole and closely uniting for a moment as if for the purpose of entirely fusing; yet they by no means utilized their union for permanent fusion of the whole, but merely to bring together the products of their division, which then duly united, two by two. You notice that we are dealing with only a secondary matter, an appendix, which scarcely affects the fundamentals. Now perform a rapid *salto mortale* from this kind of one-celled primitive being to yourself, man. Wherein lies the difference? Here are two human individuals of different sexes, man and woman. Both proceed to the act of reproduction. What happens first? Both divide? What? Do you mean to say a male or a female of the human species simply tears itself in two in the love act, like Rumpelstilzkin, or like a bacillus? No, not in two halves. But neither do the dwarfs of the last stage any longer tear themselves in half. The human male and the human female each divide, but, as in the case of the dwarfs, they divide unequally. The man lets a small piece go from his comparatively huge body; likewise the woman. More closely observed, the small piece in the man consists of a group of tiny motile swarm-cells, the spermatozoa; in the woman, of a large, ripe, thick cell,

slowly moving toward the uterus, the egg-cell. Man and woman know it is useless for them to let their division products go off entirely free on their own honeymoon. A special rapprochement of two large parent beings is necessary. While they meet, as if they desired to fuse once more, body with body, according to the hoary ancestral custom, they give one of the sperm-cells an opportunity to reach the egg-cell, and there, in the interior of the woman's body, bring about an act of fusion, which provides both cells with the necessary "living nourishment" for the upbuilding of a new being.

But if that is so, is there really no very great difference? Would you say that so far as love is concerned, our last dwarf stage with its reproductive act is really on a level with man?

Yes, in a certain sense, it actually seems to be so. To make it quite clear, let us draw another picture. The unit cell (or the unit dwarf; the name is now but an empty sound to us) uses only a small fraction of its body for reproductive division. This fraction in the one case turns exclusively into male cells, in the other case into one or more female cells. In the human being you see the same thing more specialized. There the fraction is provided, as it were in advance, inside the whole body with a sign on the door, "Department for Reproduction." It constitutes a reproductive organ. The main purpose of this organ, both in man and the dwarfs, is, of course, the production of male sperm-cells and female egg-cells; but in addition it also has a few other useful purposes. For example, it paves the way for the act of conveying the male cell to the female cell, both by serving as an inner reservoir for the reproductive cells as yet not fully matured, and by functioning externally as the transfer (reproductive) organ for the entire individual, and so on. This is the addition that you must mentally make to the picture of the dwarf and the one cell. At bottom it is nothing new. Moreover, it is merely a quite simple, natural consequence. What matters it if we do make this addition to the dwarfs? Our fancy, at any rate, endowed them with a human form. We may conclude that both the men dwarfs and the women dwarfs received regular internal and external sex organs, just like the large homo. We may draw this conclusion, I say, in the fairy-tale. But for the single cell, the real primitive beings—here we strike a critical point.

Nothing sounds more simple. In the one-celled being as well as in the dwarfs, once the distinction between male and female came into existence, fixed sexual organs with internal sperm and egg reser-

voirs and external sexual instruments for the conveyance of their respective products developed; and after they had "developed," the one-celled primitive animal was in point of sexual evolution fundamentally and completely like the late intellectual being on earth, the highly developed super-animal, man. A perspective unrolls itself.

The single cell now possessed in common with man not only the cell, that is, life, but also an exceedingly important organ. What did it still lack to become entirely human? Size, you may say. Well, size it could acquire through growth. There are organisms hardly more than unicellular, by no means microscopically small, but growing to be a yard long (Siphonanthæ). What more is needed? A number of other organs, stomach, intestines, brains, spinal cord, lungs, heart, blood vessels. Why should not these be acquired when once one organ of so great importance has been acquired? There are one-celled primitive plants and one-celled animal-like infusorians. Hence real, although relatively highly developed single cells, which, despite their unmistakably one-celled bodies, strangely enough, actually exhibit rudiments of other organs. Among certain varieties of aquatic siphonanthæ, the largest of all one-celled organisms, the one huge cell of the body develops a general form, which bears a deceptively decided resemblance to a real highly developed water plant, with the most complicated plant organs, with roots underground and green branches above ground, and tongue-shaped, serrated leaves. These very siphonanthæ also exhibit the best example of real sexual reproduction in the whole of the unicellular world. But still more interesting is the example of most of the infusorians, one-celled beings closer to animals. We have spoken several times of the eating and excreting of the one-celled beings. But how does one of these lowest little fellows, a bacillus or an amœba do these things? Has it a stomach and intestines like us? Oh, no. It literally eats and excretes with its whole body. If you feed an amœba with a particle of coloured food you see that the particle can enter through any part of the soft-celled body, that it is uniformly dissolved and worked up in the whole cell-mass, and that the useless excrement can be expelled from any part of the cell. It is the same with the eating of air, with breathing, the same with sensation, which seems to be distributed uniformly throughout the little body. And in the amœba you have seen that in its complete division and complete fusion, the same is true of its love. In the nakedest sense of the word, it "loves with its whole body," in this case even the little

nucleus, at times, somewhat more reserved, entirely entering into the action of the whole body.

But not so with the higher infusorian. Unicellular it still is just like the amœba. But observe how it eats and digests. At the very first view you see a regular set mouth-opening, through which solid as well as liquid nourishment enters. This "cell-mouth" generally leads into a short canal, a gullet, in the wall of which little rods are fixed as in a fish-basket, which in some respects, perhaps, play a substitute rôle for teeth. In some instances the mouth even has lips, in fact, a long proboscis, and often an opening at the other end, a cell-anus, is present. Only the stomach is lacking. Between the gullet and anus, the nourishment lies directly in the open cell-mass; but you observe that it is surrounded by a little drop of water, that it is moved about in a certain regular way, that it is at least treated as in a stomach. Involuntarily, you look about to see whether between the gullet and the anus there is a fixed tract or pouch, the first fundamental rudiment of a stomach or intestine. But if that were attained, why not the further differentiation into organs, the further "division of labour" of the various members of the body, just as in the differentiation of the reproductive member—and then a smooth road from the infusorian to man?

No. Actual progress from primitive being to man and generally, to the higher organisms, did not follow that simple path, but one much more complicated; a fact we must not fail to take cognizance of if there is not to be a difficult knot or even a break in the logical chain of our story of love.

The beginnings of organs in the siphonanthæ or infusorians stand as isolated and futile attempts. Long before they came into force and had an opportunity to develop, a factor in the progress of evolution had already become decisive, to which only one word gives unequivocal expression, the word "social."

I already called your attention to the social element at the conclusion of the story of the dwarfs. The fact that the dwarf (or the primitive being) no longer expelled his sperm-cells or egg-cells, but retained them was at bottom really a very simple social act. But at the time when the highest stage of love began, these social acts in the extended sense must have become highly significant, in fact, decisive for the life of the single dwarfs. Without looking for it, in the consideration of the still extant one-celled beings, we came

across such a general social fact in the globe-animalcule. What was it?

A few thousand tiny unicellular beings, still easily recognizable as one-celled individuals, through a certain loose combination form a relatively large green ball, which swims actively in the water, like a unit organism. Understand well. These cells are not "fused" with each other through a love act, thus forming out of the coalescing of a thousand individual balls one large unit ball, as it were, a single colossal ball of love. It is true, the little volvox creatures did seemingly learn a certain something from love. They comprehended the principle that love so clearly teaches, that you get further by the union of two than alone. But they did not carry it as a real love principle to the point of fusion. They merely laid themselves close next to one another, bound themselves one to the other as with threads; and thus, it is true, also established a slight, loose circulation of fluid substance through these fine threads; but no more.

However, they offset limitation in this respect by an advance peculiar to themselves. They no longer united merely in pairs, but clung to one another outwardly, in tens, hundreds, thousands. In the general volvox globes there are as many as twelve thousand. By way of the love union, with its infinite intimacy, but confined to only two members, they advanced to the social union, with much greater superficiality of combination, but with the possibility of combining in thousands.

Now examine yourself again. You as man, whom do you more resemble in the structure of your body, a single-celled primitive being or a volvox globe? Recall our conversation about the cell-structure of your body. What is a one-celled primitive being, a single amœba, or a single bacillus? One cell, this is to say, one brick of life. What are you? A federation of milliards of cells, that is, a huge house of innumerable bricks. But what is the volvox globe? A federation of several thousand cells, that is, a little hut loosely constructed of a few thousand bricks. You see very clearly that the volvox globe indicates the true road leading from the one-celled being to yourself. It is the road across the social federation of many cells, of many living bricks, to structures of a higher kind, at first little walls, then huts, then palaces, and finally high domes, from which the intellect of man looked up to the starry heavens.

It is true that this very volvox globe is, in the food by which

it lives, more closely related to plants than to animals. It is not man that could have developed from it in a direct line, but, at the utmost, the higher plant world. Yet, that black cypress there is also a mighty tower of millions and millions of cell-bricks. Moreover, we took the volvox merely because it was the example that happened to occur to us. Among the above-mentioned genuine infusorians, that is, among organisms directly at the roots of the animal kingdom, there are corresponding federations of primitive cells of the simplest nature that are nearer to the animal world; for instance, the megospheres described by Haeckel, or the Norwegian ciliated balls, in which some thirty to sixty pear-shaped cells form a common ball without really fusing. The same thing, you see.

But now look close again. Here you see the volvox globe, there the one-celled amœba, or any other unicellular being. Does the difference consist merely in the fact that the amœba is a sort of single, isolated brick, the volvox globe a community of a few thousand bricks, together forming a swimming ball, while you are a gigantic structure in human form built up of myriads of bricks? Again, no. Recollect what I told you once before. Your human body, like the body of a dog or an earthworm, is not merely a colossal, irregular cluster of cells; it is a "house" exquisitely planned and equipped. In this house the cells, like the bricks of a modern metropolitan building, form group by group special "rooms" for special purposes, whole collection of organs—here an intestine, in which digestion takes place; there a lung, in which the blood is purified, there a brain in which functions are controlled. An extremely simple word solves the riddle of the whole household.

To the little word "social" we add that other good word "division of labour."

The myriads of cells that go to make up your human body form a social federation; and, moreover, with this social cell federation, there has arisen an exceedingly wise, happy division of labour. Of the countless cells of your body, so and so many are busy with nothing but eating. They form your digestive organs, your intestines, for example. So and so many cells do nothing but hear. They form your organs of hearing, reaching into the brain. So and so many do nothing but see. They form your instruments of sight, reaching from the outer eye deep into the brain. But since each individual cell and each individual organ composed of cells stands in a fixed

social relation to all the others, then each separate function serves all the other cells. When the intestinal cells absorb nutritive juices, the nourishment thus acquired circulates freely through the rest of the cells of the body whose direct function is not to eat; the cells of seeing, the cells of hearing, the cells of motion, and all the other cells of the human body, whatever they may be, are indirectly fed from them. The intestinal cells "eat for them."

Such wonderful division of labour cannot be observed in the amœba or bacillus, for the amœba still lacks a social federation of cells. Its one cell forms its entire body and naturally must do all the work—eat, breathe, feel, and so forth. But even in the volvox globe, you seek in vain (with a single exception, which we will take up presently) for this grand division of labour. It is true there is already a social confederation. But each cell in the confederation does its own eating, for example. As yet, there is no intestine in the sense of a single group of eating cells resulting from division of labour; in other words, there is no digestive organ to do the eating for the whole cell-globe. This more complex division of labour, like many, many other forms of division of labour, has evidently evolved only along the road leading from cell-spheres like the Volvox to yourself.

But the social confederation of many cells once given, the evolution was most natural, in fact, almost self-understood. Follow up one example in detail, eating, for instance.

Some two dozen cells attach themselves firmly to one another and form a swimming ball. Each has a fine vibratory process, like a projecting hair, by the aid of which it used to swim alone. Now they all swim together, in unison, habituating themselves to a certain rhythm which makes the ball whirl about as it swims. This in itself is not as yet real division of labour, it is merely the first form of social activity. But once it is present, it must of itself lead to the beginnings of division of labour.

At first each of the conglomeration of cells eats for itself. But since the cell-surfaces which lie close-pressed against each other, or even dovetailed, or lie, as it were, one rooted in the other, can be penetrated by liquids, it naturally happens that the elaborated nutritive juices flow from cell to cell, from an eating and digesting cell into a neighbouring cell, which is not eating. That in itself would be no more than a simple consequence of the social life, though under certain circumstances a very advantageous one, especially for the

neighbouring cells. An additional element enters. The cells that eat and digest will naturally, while engaged in eating and digesting, do less of the other work than the remaining cells. They will not move their oar-processes so vigorously, perhaps not at all. Nor do they need to. For—again a simple consequence of social union—the other cells wiggling and rowing briskly will carry them along.

You observe that this is the commencement of a natural benefit. One cell eats for several surrounding cells. In return, these move it forward gratis as long as it is eating. The forward movement is in itself beneficial in offering opportunities for finding new food; and though the eating cell expends some of its nutritive juice upon its neighbours, it soon has a chance to make up for the loss. Being kept in motion while it eats, it comes across food that otherwise it would have failed to obtain. What if it were possible to transform this beneficial mutual relation into division of labour?

Assume, for the sake of simplicity, that of five cells one, say the middle one, undertakes to do all the nourishing for the four surrounding ones, and, in return, to enable it to do so, the four engaged to keep it in constant motion and, moreover, in especially lively motion. All the one needs do is eat, concentrate its entire energy exclusively upon eating; all the four need to do is move, concentrate all their faculties upon moving. At once you see that the advantage is unmistakable. Now, this simplest of examples probably contains the kernel of the whole intricate evolution of this aspect of life from the volvox sphere to man.

Perhaps the use of certain words in this connection irritates you; you say they have too human a sound—division of labour, mutual aid, social federation. Strangely enough, here we are not, for the sake of greater vividness, borrowing a picture from human life. The facts corresponding to the terms are actually to be found both in plants and animals far lower than man. There are animals that live socially. Think of the colossal states of ants and of bees, illustrating far-reaching mutual aid among the members of the state and division of labour in a most highly elaborated form. The queen bee "propagates for all." In return the other citizens "feed" her. We shall come back to this subject again. The matter goes a great way further than division of labour carried out by animals of the same kind. For mutual benefit certain ants live in community with much lower animals, the plant-lice, which with their sugar-sweet urine provided the ants with a delicacy. For this tribute, the ants, which

are strong in defence, protect the more helpless plant-lice. Crustaceans club together with animals far, far removed from them, the polyps (sea-anemones). There are animals that live in community with plants. And among plants, the custom of conjoint living is found even in a more complicated form. Some fungi keep so closely intertwined with certain algæ, live with them so intimately for mutual aid, that botanists, misled by superficial appearances, for a long time regarded them as a special plant, half fungal, half algal, to which they gave the name lichens. Scientifically, the phenomenon is known as "symbiosis." The word means "living together," in more pregnant phrase, "sticking together for mutual aid." You will find symbiosis now mentioned in even the better school books on natural history. Since fungi are low plants and algæ among the very lowest, we need not be at all surprised if in a genuine one-celled being we find a development already existing in these extremely low organisms. So, if anyone tells you that to speak of "division of labour" here is anthropomorphism in the wrong place, send him to the A B C school of modern natural history, and calmly proceed on your way.

Hence the further action of this principle, which we shall presently observe in our ball of five cells, is almost self-evident.

As the cell-ball moves in its habitual way, one pole forward, this forward pole, that is, the cells situated there, must receive the food that comes swimming toward it. On this pole there gradually developed a fixed mass of cells that did nothing but eat. They provided the entire trunk with nutritive juice, and were moved by the rest of the cell-federation from purely utilitarian motives. Were the motor cells with their vibratory hairs, energetically and without delay, to throw backward along the ball's sides every bit of food that came their way, then, it may be imagined, the hind pole would also offer a good place for eating, since it has the additional advantage of having a more protected position. Be that as it may, one pole was always the best place. Now, the area of an eating pole was always limited. With the growth of the whole colony, an extension of the area would prove highly advantageous. What was to be done? Think of a terrestrial globe that rains roast squab at the north pole. Only the few persons that could find standing-room on the pole could catch them. If they haven't enough hands, the blessing rebounds and whirls back into space. What will inventive minds do to increase the number of hands despite the contracted

space for standing on? They dig a hole in the pole, lean ladders up against the sides of the hole, and place men on the rungs, one above the other. To place ladders above ground would not be so practical. The ladders might topple over and the men break their necks. To do it underground is safer every time. The eating cells at the pole of the whirling cell-ball form a groove, a depression, and finally a real cavity, the walls and bottom of which they occupy. The vortex produced by the little whirling body draws the floating particles of food down the mouth opening. Here the eating cells can work the food, protected and undisturbed. What is the result?

As the pole sinks into the shape of a funnel, the ball becomes a goblet. Finally, it has a cavity inside, the outer opening of which is the mouth. The wall of the ball consists of two layers of cells, the original cells, and those which gradually sank in from the pole, like the finger of a glove turned inside out. The outer wall now contains only locomotor cells; the inner wall, only eating cells. Instead of a simple, many-celled sphere, there is a federation of cells and the first division of labour, moving and eating. The outer wall is a skin with locomotor organs, the inner wall, a regular stomach, or intestine. From this organism to you, the distance is much shorter than from the simple volvox. It shows division of labour in full swing. It has a mouth, skin, and intestines, like you. It is no longer a simple cell-pyramid without content. It has, as it were, two rooms set inside each other, one a dining-room with a door. It is a "house" in the real sense in process of building, still simple, yet, strictly speaking, separated from you by its simplicity alone, not by its kind.

All the higher "animal-houses," the dog as well as you, the oyster, the earthworm, the starfish, all these, in the complication of their drawing-rooms, halls, closets, attics, can be traced back to the simple little house, with its first division of labour. Even now in the development of the individual from the egg, a number of the higher animals in the first phases reveal the little primitive house. From the fertilized single cell of their egg, cluster of many cells, like a volvox, is formed. In this cell-sphere, the groove then sinks in until the funnel-like form is reached consisting of a mouth, intestine and outer skin. It is only through further, more complicated developments that the large house, the worm or starfish, is reached. In other instances the course of these first phases is not so clear. Nevertheless, the starting-point from the original cell-layers is al-

ways apparent. And so it goes on up to yourself. The entire upper part of the tree of descent must once, after the volvox stage, have passed through this skin-stomach form. Haeckel, who was the first to grasp this idea in a happy moment, called it gastræa, from the Greek *gaster*, "stomach," the primitive stomach-animal. As the present volvox and its animal representatives are survivals of loose cell-combinations—organisms that have never gone beyond the first social stage, living relics of the primitive form of cell-combinations —so certain animals, still extant, are in the opinion of some naturalists—genuine gastræa. However opinion differs in regard to this, though, on the whole, there is no doubt all higher animal formations began with the gastræa stage. Like the worm, the crustacean, the insect, the shellfish, the cuttlefish, fish, frog, lizard, bird, urchin, horse, and ape, so you yourself come from a primitive gastræa, the first cell-combination consistently to carry out a specialization of functions in motor cells and eating cells, skin and stomach.

Do you now perceive the difference, the enormous difference? You were on the point of deriving man in a regular chain from the infusorian, which in its unit cell evolved a cell mouth and so forth. In vain. You will never succeed in establishing a connection between that one-celled being and the huge cell-dome, man, even if it had a hundred organs in its one cell. In fact, it seems that the social combination of many cells for the formation of a new kind of higher individual, with division of labour by cell-organs, has paralyzed and done away with the simple formation of organs in the single cells and in general with further individual development in the single cells. It has remained an abandoned sidepath apart from the real progress of evolution. The higher beings on earth did not arise from the infusorian; man did not arise from the infusorian. All higher animals, man, too, rest upon the basis of the infusorian state, upon the basis of the social combination of many infusorians. which gradually became the foundation of new higher individuals.

This origin of new individuals from social combinations is certainly a wondrous process in itself, worthy of the profoundest thought.

You are an individual, an ego, are you not? You yourself are the typical example, the archetype of the individual. And yet here you are and here is the whole of mankind sprung from the combination of many millions of tiny cell-individuals in a social community, so

closely knit that the whole seems to you like an ego, an individual, aye, like the true type of a homogeneous ego.

In its psychical bearing the phenomenon is especially remarkable. Imagine, let us say, that fifty cells enter into a social combination, which can be effected, even without direct coalescence, through the fact that the cells are open to one another. Nutritive juice can circulate freely through all the cells. Thus, it is quite plausible, that physically they become, in a certain sense, a higher "unity." But now consider the thing from a psychic, from a spiritual point of view.

Doubtless from the very first each individual cell, each primitive cell, the original source of all life phenomena, had its individual little "psyche" or "soul," its "cell-soul." Even today every bacillus, every amœba, every infusorian has its own little soul. You may conceive of "soul" as you please—I have already given you free latitude in this respect—you cannot get around this simple fact. There is absolutely nothing miraculous in it. It is, on the contrary, the self-evident assumption. Every unit cell has a soul which feels, which adjusts itself to things in the simplest way, which learns, and apparently represents—this is the principal thing in the sensory life also—a unit, just like the cell, which, complete in itself, represents a physical unit. This and nothing else is here the significance of the concept "soul." But neither does it signify less than that. That a "soul" should be attached to a cell, need not surprise you. For even in yourself the soul is still attached to cells, nothing but cells. Even your wise human brain consists solely of living cells.

But the remarkable part is this. The unit cells combine into a volvox globe. For the time being, each single cell in the globe preserves its individual existence, hence also its soul. But despite this, you immediately perceive the beginning of a sort of spiritual flow from one cell to another, just as the simple aggregation of many cells into a globe is the beginning of at least a bodily union, of a new higher bodily structure. You see the cluster "inspired" by a common directive force. As the ball swims along, as a whole, moved by thousands of vibratile hairs, you see the many little soul cells "thinking in common," "willing in common" as it were, mutually adjusting themselves for definite, collective movement. "But," you say, "is that so very different from a troop of soldiers marching to the same time?" No, it is not; but something else, something addi-

tional is required. The physical connection of the cells, at first leading rather accidentally to the interchange of substances and finally producing the regular transfer of nutritive juices and so on, must increasingly have effected in these cell clusters a psychical interflow also (this, of course, in a figurative sense), of which social unions among men give you no idea, at least not according to our conventional conception. And the result evidently was (quite apart from the division of labour, which, just as it led to the formation of a special eating organ in the stomach evolved also a special "soul-organ" in the higher animals as a controlling centre in the brain) that the whole cell-state also received a unit self-consciousness, the very kind of self-consciousness that you as a unit feel in yourself. How this was brought about—this fusing together of millions of spiritual egos, in a sort of mysterious soul generation, until, finally, a new "Super-Ego" was born, again comprising the content of millions as unity—that is the extraordinary, the supreme riddle. Every philosophy dealing especially with the spiritual aspect of phenomena and world-evolution is at this point confronted by a problem calling for its profoundest reflection. The further consideration of this problem would lure us into an endless discussion of the most difficult questions. It would carry us away to psychical milky ways, just as before we were led to the physical milky way. Perhaps you will mark this exit to another field in red, and return to it again and ponder it further. We must not go too deeply into the subject, else our golden thread of love will slip from our hands in the medley. Hence, instead of venturing upon spiritual by-paths, where the intellectual moss of centuries muffles the sound of your footsteps and obliterates your traces, until you lose your way and disappear in Merlin's fabulously green forest, let us consider what relation the evolution of love bears to that tremendous new fact of social cell-combination with division of labour.

§ 4

It is really a very simple question, and at bottom again merely a consequence.

I have told you enough of the love story for you to see that even in the one-celled being one part finally divided itself off as a reproductive corner. It was exactly in connection with the love act that the first division of labour set in. The male cell-body, for example, no longer split up in sperm-cells in its entirety, but reserved a corner where the splitting-up of the sperms took place. We compared this with a higher animal, with yourself. And in you, too, we saw that the reserved corner developed, both in man and woman, into a regular "reproductive organ."

In the meantime we have been enlightened as to the fact that an organism like yours is not a simple parallel to the early one-celled being, but that you are a huge social community of unit cells. In this community every "organ," hence your generative organ, is likewise a cluster of cells, standing in the relation to the other organs that arises from division of labour. Your male organ, which produces sperm, is no longer merely a reserved corner in a one-celled body. It is the corresponding cell-department in a large cell-union, the cell-department which produces sperm-cells for all, just as the intestinal department digests for all and the brain department thinks for all. The same is true of the woman and her ovum organ.

This new social situation somewhat complicates the story of evolution; but in detail the logic for the "love corner" must have been precisely the same as for the eating corner.

The path to the human stomach, we learned, did not run directly to us from a unicellular being with a stomach. An intermediate stage intervened, a volvoxlike cell-community appointing a definite part of their members to the department of "pure eating" and so forming a many-celled community-stomach in the union. That is what our own stomach in our many-celled body is.

In exactly the same way a volvoxlike, primitive cell-union of this sort must have carried division of labour still further and chosen a part of their members as pure "reproducers," members so chosen

discharging the business of reproduction for all the others. It was thus that our reproductive organ was reached in the many-celled human community of to-day.

There is really not the slightest reason why that which happened in the matter of eating could not also have happened in the matter of love. Each cell in the union originally felt the need for eating and excreting, just as it felt the need for self-division, for the purpose of sending forth love elements in quest of love. But if division of labour brought about the complete release of so and so many cells from the duty of eating, then why not also from the duty of love? If in the case of a single cell it was a permanent advantage, aye, even a sort of division of labour, for the cell-body to reserve a part for the breaking-up into productive pieces, instead of having the whole break-up in every love act, then how much more of an advantage was it, when out of a hundred cells, ninety-nine could set aside one cell to undertake the whole business of reproduction by dividing into sperm-cell or egg-cell. It was an advantage in the sense that these very fusion and coalescing acts were acts of labour; it was of the same advantage that it is to us for our heart, our lungs, our stomach to go on doing their work more or less quietly, while simultaneously the sexual organ is performing most intensive labour.

It is that instructive little tribe from the race of Volvox in which we can see this development most vividly.

Previously I mentioned Volvox only as an example of the first social combination in general. Division of labour in eating, our first and most evident example of division of labour, was, on the other hand, still entirely lacking. No volvox has yet reached the gastræa stage. But as an exception, or rather, as a first start, volvox shows one true form of division of labour, the specialization of the labour of love, the evolution of a special cell-department for reproduction in the many-celled community. Evidently love here had progressed further than eating; and there is nothing to indicate that this was not the general rule in the evolution of organisms. But inasmuch as not all volvoxlike beings of to-day possess this division of labour, but only some of them, and side by side, there are others, which, though they form social balls, have no special reproductive department, you observe perpetuated to-day not only the completed step, but even the various stages, the transitions to it.

Thus, there is a group of volvoxlike creatures, the genus *Pandorina,* consisting of a ball of sixteen special cells with no trace of the division of love-labour. For the purpose of propagation each of the sixteen cells divides, and the parts coalesce in the higher love act (in conjugation) with the parts from another ball.

In a volvoxlike genus closely related to it, *Endorina,* forming social balls of about thirty members, the same is true in respect of division of labour with one exception; and the exception is in itself instructive. Each cell of the spherical social combination still produces generative cells independently; but in most cases the balls as a whole produce some only small motile male-cells, others only waiting larger female-cells.

Thus, there are, so to speak, "male" and "female" balls. In order to explain with absolute clearness how this last differentiation could arise, I must enter more deeply into a matter that I have already mentioned. In the story of the dwarfs, I told you, by the way, that the fusion dwarf (the single fusion cell), which arose from the coalescing of a male and his female consort, divided in such a way that he produced either male pieces or female pieces. The matter, as I told you, "regulated itself in a satisfactory way, according to certain conditions alternately predominating pretty much in conformity with the requirements of dwarf life." Some of the newly born dwarfs produced males, some females. Thus, of the new material there was as much male as female. But I did not enter further into the paths that this arrangement followed. It was sufficient to know that Fairy Utility must have carried it through. Otherwise the thing would not have worked; and if you glance over the entire situation you will see that it required no special miracle. After fusion in the proportion of half and half of the chromosome rings, some natural cause had merely to exercise a special force to bring about further division, now into male, now into female parts. Strictly speaking, however, I should have had to dwell upon these causes once more, when I translated the fairy tale of the dwarfs into the actual relations of unicellular organisms. The reason I did not do it was, frankly, that there is still a little lacuna in our knowledge.

To this day science does not know why one fertilized egg produces a male child, another a female child. What we do know is that the proportion is approximately equal in man as well as in the lower organisms, so that in each generation the same number of

men and women is about the same. But the thing of which we are ignorant is the law by which constant alternation is effected, the cause determining, in every instance, that the fertilized cell should turn out a male or a female. Knowledge of this law would mean much to us, since in time we should be able to control the ratio of male and female births. Despite what Professor Schenck and so many others have written about it, we actually do not possess even a single hypothesis worthy of discussion. Nothing remains but the fact, which is indisputable. Since we are unacquainted with the cause in man, we are, of course, equally in the dark with respect to other organisms. For in this most intimate primitive act, human generation, as you saw, is merely an instance, an individual repetition, of the whole of cell-generation. To be honest we must leave this question open; it will not hamper us materially in understanding the ancient romance of love. That it has no fundamental significance is quite evident. And it is also evident that however much it may mean to us higher animals, it was originally only a small, necessary special arrangement.

If here, too, we let the fundamental "Why" rest quietly, we shall on that account have no fresh gap in our many-celled stage. Once we take the beginning for granted, we can without difficulty conceive its logical extension into the future. There is nothing to prevent us from picturing to ourselves that when the first social groups formed, of which the volvox spheres still give us such neat examples, in many cases the cells that clung together contained the material for equal division, that is to say, that tending to division either into purely female or purely male elements. The natural consequence of this must have been that one volvox colony, when it proceeded to the act of propagation, yielded, after the fashion of the eudorina, in all of its thirty constituent parts, purely male products, another, purely female products. If for once you desire to indulge in speculation, assume that this tendency was due to a chemical cause, that the chemism expressed itself in a definite smell, and that from the very beginning, in the formation of social unities, there was in certain directions a preference for the same sexual odour. Expressed in a human way, it would mean the fact still holding true that where it is not a matter of love (and there was no love within the same volvox colony), boys as a general rule prefer to be with boys, and girls with girls.

I have said that there was no sexual love within one and the

same colony. This gave rise to another very natural, logical consequence. In addition to the higher form of love-life, sexual reproduction has to this day remained, as an optional secondary custom and practice among unicellular beings, the original form of simple multiplication by fission. The production of several new egg-cells or sperm-cells from each fertilized cell, which is a necessary prerequisite to the mixed act of sexual love, is in itself made possible only through the intervening sexual act of fission. Now, in many cases among the single cells we observe that the fertilized coalesced cell does not immediately proceed to the self-division that again ushers in the new act of coalescence. That is to say, it does not immediately produce new genuine child-cells in the form either of male sperm-cells or female egg-cells, but, at the height of its power, duplicates itself. In other words, instead of dividing at first into new generative children, it divides into two parts, each of which may then either produce real generative children, male or female, or, before passing to the sexual form of reproduction, may multiply again by simple fission. Imagine multiplication by fission to continue for some time. Then you will understand how a large family mass might easily have arisen at the same spot, the members of which then proceeded to the form of fission requisite for sexual interminglings. Now what was more natural than that these very family members should, in the social tendency, form the social community-ball? If the first cell that formed the starting-point of the family mass was, through the unknown cause to which we referred, destined to produce only female generative parts, then it is plainly evident that the products of the division should preserve that particular tendency. The whole ball would then be composed either of sisters alone, or brothers alone. There would be strictly uniform brother balls and strictly uniform sister balls. Thus, we should have the case of the eurodina even more evident. Inbreeding here would be out of the question. Sisters never marry sisters, nor brothers, brothers. They would merely live together socially and produce material which would cross-fertilize from ball to ball.

It is true there are in addition (this was of great import at the very origin of sex) in the many-celled organisms, higher Volvocineæ, just as regularly uniting both sexes in them. That is, containing in one and the same sphere cells some of which propagate male elements, some female elements. One species of the true genus Volvox is particularly stubborn in this caprice. The combination

of male and female producing cells in the same community must therefore have been a possibility for the many-celled beings even in most primitive times. That a mixed brother and sister ball produced sperm-cells as well as egg-cells did not by any means do away with the search for the corresponding products of a second ball for the purpose of generation. The cells of the mixed ball remained genuine brothers and sisters, and therefore required freshening up of the blood through cross-fertilization. The case of the mixed ball, therefore, is very instructive, and you must particularly impress it on your mind, since, as I have already told you, a number of animals and an immense number of plants, even with a perfected many-celled organism, have maintained themselves as "hermaphrodites," possessing both the male and the female organs in one and the same body. Ordinarily, however, hermaphrodites, despite their dual sex organs, must look for other hermaphrodites in order to reproduce through cross-fertilization, and prevent the destruction of the species through inbreeding. I will return to this subject later. In the meantime, let the mere fact suffice.

But no matter whether the social ball in the long run is always purely male or purely female or double-sexed, that is, hermaphroditic, it is clear that in the narrower genus Volvox there has finally appeared, as the crown of the little ancient social romance, the starting-point of the new, of progress in the whole love romance even in the highest organism—division of labour in the social community of cells. Henceforth, instead of all the members taking part in reproduction, only a few assume the entire work of generation and constitute the whole reproductive department. Now you can really speak in the simplest sense of the reproductive organ of the many-celled organism. The reproductive cells no longer develop motor oars for the whole, hence do not row (just like the gastræal eating cells). In their own time they, too, withdraw into the inner space of the hollow sphere, busy themselves only with their reproductive task, produce their parts, and finally even wander forth independently through crevices in the social sphere. And this task of theirs serves for the whole ball as its only participation in love and in the maintenance of its kind in the world. Should they leave anything undone in this matter, it would be lacking in the whole ball.

After its work has been accomplished, and all its products have left the ball through the crevice, it collapses like a punctured bal-

loon, sinks to the bottom and dies. With the departure of the fleet exclusively entrusted with the immortality of love, its eternal rôle has been fulfilled. Thus, the ball in this respect, too, bears the consequence of division of labour. It ceases to exist with the termination of its individual span of life. Release from love means release from permanent existence.

As long as all the cells of a ball broke up completely into love parts, say sperm-cells, all had the chance of immortality. The volvox organisms are still living to-day, apparently after millions of years, during which time, therefore, the generative thread could not have entirely snapped. Certain happy chains of the product of fission have persisted throughout the æons. But from the moment when division of labour released so and so many hundreds of cells from love in favour of a few, then, for the cells thus released the chance of immortality was absolutely and instantly cut off. For them death, the snapping of the great golden thread leading to the future, was no longer a merely accidental possibility, such as might befall a swarming cell going out in search of its mate. For them it was strictly logical fate, the reaper inevitably mowing them down to the very last head, even in their own generation, the fate that sprang from the very conditions of existence, from their very life contract, their social contract.

In more than one respect, therefore, you are now viewing a highly significant factor, not only in the story of love, but in the whole story of life. The roads that some of the profoundest philosophical problems travel lead to the tiny green volvox ball. Division of labour appears not merely as an important stage in the evolution of love; it also reveals a relation between itself and death.

You recall what we said of the great distinction between personal death and the continuous reproductive immortality of the chain of love on earth. To be sure, death in a certain sense has existed ever since there has been life in our planet. Even at the time life was represented by none but one-celled beings, a tremendous part of organic life was no doubt continually being destroyed by external violence. Every storm, the slightest event in nature causing unexpected jarrings, every change for the rougher in light, heat, and humidity must have crushed, burned, dried up innumerable unit cells. That is so to-day. It must surely have been so always. Nevertheless, a countless number of creatures have survived. Their part of the chain of love has never snapped. Otherwise the higher

forms of life would never have been reached, since they are traced back ultimately to one-celled beings, way, way in the past. And a mighty war has been carried on against accidental death also. Inexhaustible are the adaptive weapons that these very one-celled creatures have contrived. Medical science, which would so gladly employ violent means of destruction against wicked bacilli, can tell a tale about it. We have mentioned the extremes of cold, for example, that certain bacteria are able to withstand.

If they succeed in defying the sudden stroke of external violence, and as long as their entire cell took part in love, there was no intrinsic necessity for them to die. In ourselves we see death from intrinsic causes connected with a certain term set for the life of the individual. For a while the individual constantly renews his body by metabolism, like a burning flame. Gradually, however, a sort of self-consumption sets in. In that metabolic renewal of the body through the taking in of food and through excretion, there is not only constant restoration of the *status quo,* but also positive increase. There is growth. We get the impression that, in accordance with a primordial law of life the circle of the individuality is unable to maintain growth beyond a certain limit, or keep it intact. After reaching a certain stage, the matured body must either divide into two individualities, or else the machine will get out of gear. A deficit of the working forces sets in; the life process permanently confined to the one individual degenerates and finally comes to a standstill. Multiplication by fission now appears as the primitive simple means against this fatal outcome. In the original one-celled beings, it was applied in a truly radical form. As soon as the growth of the body reached a critical stage, it simply fell into two or more pieces, each of which represented a new individuality (recall our story of the dwarfs). Nothing of the old remained. Thereby the game of immortality was absolutely won. At the moment when inner death might have set in, love outbid death with a new life.

At the beginning of our dwarf story I represented this method as already a fixed custom. Perhaps cell-life, where it appeared at all in separate individualities (single dwarfs), immediately brought with it this solution, this plausible auto-regulation, or perhaps it took a long time before Fairy Utility succeeded in introducing this method. In that case cells continually formed by spontaneous generation would for a long time have experienced death from inner cause until at length the first reproductive division took place as

an ingenious mode of salvation, and thenceforth made spontaneous generation superfluous, since reproduction checkmated inner death. But the inner nature of the individual must have carried with it the possibility of death as well as the possibility of escape from death through reproduction. Thus the kernel of this question remains concealed in the primal mystery of life.

Into this paradisiacal, primitive condition of the absolute overcoming of death through love in our primitive cells (or dwarfs), there now entered the first shadow, when for the first time one of the cell-dwarfs divided unequally, and the larger piece took no further part in the love processes (the fusings in sexual love and the further divisions connected therewith). Even here, in the single cell, this conduct signified, as I already told you, a simplest form of division of labour. But this very division of labour now interposed to produce on the one hand perpetual reproduction through love, on the other hand, the death of the simple individual parent cell, which, after liberating its love part, remained behind in its old age. Within a limited time inner death marched inexorably upon the parent piece. Division of labour was purchased at the price of making one piece a sure candidate for death while only one other piece of cell remained immortal. It is this state of things commencing on a large and mighty scale with the first combination of many cells in which there is division of labour for reproduction that you see in our volvox. In order that one cell should love and that ninety-nine, released from the business of love, should be able to do other work in the social cell-ball, these ninety-nine are excluded from the immortality of love. The cell-ball that they themselves compose bursts, degenerates, and dies within a short period, while the love-cell has in the meantime fared forth in order, through sexual mingling and the new division connected therewith, to form new brotherhoods and sisterhoods and thus construct the foundation for new social volvox communities. But since we human beings, as many-celled organisms, are historically connected with volvoxlike stages, it is our own individual death in the sharpest form that we are here for the first time confronted with. Strange Volvox, it was due to the step you took at this huge turn of things that Goethe had to die.

Instinctively one feels the need here to make a quiet pause in one's thought. Our time does not like to clothe its truths and probabilities, in the garb of mysteries, which the poet takes and gives

new life to. The kernel of the idea I have just presented to you was first expressed by a very sober biologist, August Weismann, in connection with special technical discussions, which no layman can easily follow. Think what this idea would be if the art of a Milton or a Dante transmuted it into lofty symbolic pictures. For in the creatures at that volvox stage, man in course of evolution was actually contained by destiny's mysterious ordainment. If the seer-like power of the poet were to fashion these primitive creatures into dreamlike foreshadowings of man at the beginning of things, symbolically endowing them with the human form, with naked human bodies, and sensitive human souls, driven about by the vicissitudes of fate and responding to them with human hopes, human tears, human moods, as the myth pictures Adam and Eve, and if the tragedy of death had overtaken them, what a tremendous, overwhelming conflict the story would picture. You would have dwellers in paradise who had entered upon a new path with proud hopes who had broken off a precious fruit from the tree of evolution, and progress—the blessing of association, of work in common, of mutual aid, of division of labour. A new cosmic day had seemed to break. Then something fearful befell them. In the primal paradise lay the first corpse. Death snatched its first victim, death suddenly emerging from the flowery hedge, like the angel with the flaming sword. Henceforth, you must all die, because you have eaten of the new fruit. What hitherto hovered over you as mere chance, that henceforth shall dwell in the midst of you. Here lies the first corpse struck down by inner death, the first old man. Myriads will follow in the stretches of time. Even the greatest genius will age, and one day lie on the bier. Drive men upward and onward to glories unspeakable. Let them read the stars, let them sing of all the depths of the human breast. The law of the volvox will remain hanging over them. When their hour strikes it will mow down the star-gazer and the poet, like grass.

Our time is no poorer than former times in sublime material for mysteries; it is merely more disjointed. Our poets as yet have no glimmering of the very quiet spots where fresh wells are gushing.

The poet who would let a pale dawn of consolation rise above the horizon of that fearful tragedy of the expulsion from paradise, would perhaps have a voice to speak in somewhat the same words

that Jehovah spoke to Job, that our fear really proceeds from the belief that we know what death is; whereas at the very bottom of things we know too little of what life is, what individuality is, to understand what death is.

The scientific investigators may add that at all events there is a strong probability that the fear of death itself, the dull fear of the individual confronting death as an evil, is nothing else than, you may say, one of the little artifices, one of the little utilitarian devices of evolution to cause us to assert and defend individual life as long as possible with all the powers at our command. This would not be the first place where nature has imposed the demand on her creatures to fight for a thing desperately with all their energy, though the thing is not necessarily of absolute good, nor its opposite of absolute evil. Thus, in the course of the evolution of life, we see animal and plant species securing all sorts of means of defence, all sorts of tenacities. Yet, in the end, progress marches along the path of mutation of species, in the course of which aged forms after glorious resistance at length succumb with honour. It is interesting in the extreme to observe that when the momentary and unconditional sacrifice of an individual life serves a higher purpose, the fear of death in the economy of life can be eliminated from nature instantly and thoroughly. This is to be observed whenever an individual makes a martyr of himself for the preservation of a community. We all know of examples of such martyrdom among men. Among social animals, especially among bees and ants, absolute self-immolation for the good of the whole is the more apparent since their impulses and instincts manifest themselves in so much more striking a degree—on the one hand, fear of death as the purely defensive instinct of the individual inculcated by utility, on the other hand, scorn of death as the equally strong expression of the social instinct. In this connection it is significant that, according to the story of the expulsion of the volvox from its paradise the great fundamental form of individual death, due to inner cause of decay through age, is the consequence of a social act, a result inherent in the blessing of primitive division of labour, where the individual was for the first time called upon to work for others. That one portion of the cells of the volvox community excluded itself from the work of reproduction and thus gave up its form of immortality for the benefit of the whole, for the benefit of reproduction, itself signified a sort of sacrificial martyrdom. And so it

may be said that to this very day every inner death is really a noble sacrifice, at least in its deepest essence. The fear of death, it is true, has not been eliminated. Apparently it was nature's intention to preserve as long as possible even the cells that no longer directly participated in reproduction.

At all events, multiplicity of cells and division of labour represented an enormous advance in the general evolution of organisms, constituting the foundation upon which all higher life was raised, making possible the evolution of colossal individuals, such as the hundred-feet-long brontosaurus or whale, and above all making possible the evolution of so wonderful an organ as our human brain, the cell-department for concentrated sensation and movement, for orientation and mental control. And since this great advance led along the path of love and was connected with love, it necessarily formed a turning-point of first importance in love-life also. But forthwith an acute problem arose which called for instant solution of some sort.

Thereafter, from the very beginning, the cells of the colony divided into love-cells and non-love-cells. When the colony matured and the time for reproduction came, it was the love-cells alone that yielded the chromosomes for the group. In dwarf language, they alone gave off the rings of fate which carried their influence into the future, and built up a new generation upon the basis of those rings.

Here a question arose.

The love-cells love for the entire colony. Now what influence do the non-loving parts of the colony in their turn exert upon them?

For a while, until they reach the time of genuine love, of reproductive maturity, the love-cells are nothing but a part of the large colonial society. In the volvox colony this period may not last very long. As for yourself—we are quite justified in leaping from Volvox to you—the reproductive department in the cell-colony of your body was already formed when you were still an embryo in your mother's womb. In every girl's body from her second year on, the eggs, that is, the genuine female love-cells, are to be found in their primitive form individually separate as if ready any day to begin their migrations. Nevertheless, as you know, it takes many years more, in our northern countries often fifteen years or even longer, before the first menstrual flow indicates that an egg has at length actually started out on its migration waiting for a sperm-

cell from another colony. What during those years, does the colony do for its egg?

It moves it. This is true even of the volvox colony, where the first external mark of the love-cells is that they lack locomotor "cilia"; they let the other cells do the rotating for them. Further, the colony offers the egg a protected shelter in its interior. This, too, is evident in Volvox. In the gastræa stage, higher than Volvox, where a definite part has evolved to attend to the business of eating for the whole colony, the love-cell is, of course also fed. So it is with you. The girl carries her ovary concealed deep in her body and the ovary (or, in the boy, the spermary) has no special mouth for breathing and eating, no special stomach and lungs; the eating and breathing are done for it by the general mouth, stomach and lungs. This is all quite clear.

But such a colony also leads for weeks or for years an individual life as a unit. It has personal adventures, it experiences good and evil. The experiences of a little green volvox in its whirlpool are probably not extensive. But turn to yourself again. Think of all the personal experiences of a child from its embryo stage in the womb to the first maturation of the egg or the sperm, which is far from being the last egg or sperm to escape. When a dignified man of sixty begets a child, what intensive life, what adventures and experiences have through all the decades accompanied the last sperm-cell he sends forth from his cell-colony to form a new human being! Think of a butterfly. As the gay-winged creature it now is, it becomes ripe for love. But what things it has been through in the long period when it crawled out of the egg as a tiny larva, ate and grew as a larval caterpillar, and finally, in the form of a chrysalis or pupa, rested as in a coffin. The pupa of the European goat-moth often requires three years for its development. What an opportunity for individual experiences of all kinds! Now the question is, does the love-cell also receive something of these personal doings and stirrings of the large colony?

Originally, when the love-cell itself was the entire being, the entire individual, it certainly did; each individual experience was also its experience. But how was this matter regulated when division of labour arose? To speak once more in the language of the dwarfs, when the whole colony passed through a certain personal experience, when it acquired something, could that still be transferred in some way as a new inscription, as new runes of destiny,

to those most important rings which belonged to the love-cells, to the dwarf that the tribe chose for the business of love? And did they transmit the new acquisitions to the new colonies?

The answer at first glance seems self-evident. Of course, if for a certain period, the love-cells form so close an integral part of the whole colony, then during that period they must experience whatever the colony experiences. And since afterwards they build new colonies, they must bring these experiences into them. If the whole colony suffers from hunger and grows weak as a result, then the love-cells, since the colony feeds them, must also be affected. If the dwarf colony is drenched through and through, then the love-delegates will also be drenched, and if, in consequence the magic rings rust, the rings of the reproductive cells will also rust; and the transmission of the rusty rings will necessarily produce a degenerate offspring. If, in the human sense, the colony has brought a drenching upon itself, then the sins of the father are transmitted by heredity to the children of the remotest generation; except in so far as the subsequent experiences of the grandchildren succeed in happily removing the rust from the ring or in so far as that exquisite gift of Nature, the intermingling of the sexes which always throws in a new ring as a fresh contribution, gradually repairs the harm done.

You need not look far for pictures to illustrate this process. You can find very real examples of it from the lower organisms all the way up to ourselves. A poison taken into the human body by way of the stomach will slowly eat into the whole cell-colony, injuring one cell after another, affecting the love-cells, too, attacking their chromosomes, and corroding the metal of the magic ring. As a result, the entire runic inscription is damaged, it loses characters, and the noble ancestral tradition is debased unto the seventh generation. You know, our physicians are fairly agreed that alcoholic poison, for example, is an injurious agent of this kind. It acts as a diabolic corrosive not only upon the stomach, kidney, liver and brain-cells of the individual colony, but inevitably makes its way to the secret fortress of the egg-cells and sperm-cells, and there insidiously eats into the chromosome rings, so that the innocent offspring inherits the injury. Fortunately, in this case it seems that the freshening-up with healthy blood, that is, with uncorroded half-rings, effaces the evil consequences sooner than some pessimists think. In this case also sexual love with its inter-

mingling of foreign blood proves to be Nature's great gift for counteracting the fearful visitation of the sins of the fathers upon the remotest generations. You find a similar state of things, though apparently still more complicated, in syphilis, a subject we shall discuss later.

It is not only in poisoning that the love-cells share the colony's great individual experiences, which pass from cell to cell. They share various other kinds, some of which are at first not dangerous. When a poor girl is cold, her ovaries are also chilled. There are cases in the animal kingdom where cold without producing the damage done by actual freezing may yet bring about exceedingly curious disturbances in the cell-life, affecting the non-love-cells as well as the love-cells, and transmissible by way of the love-cells to the children and grandchildren, so that the bodies of these, although themselves not exposed to cold, will exhibit certain remarkable traces of frost.

A number of years ago a peculiar thing happened to the butterfly collectors. They had to strike out of the system one of the best-known species of European butterflies. There is a black butterfly with white band, in scientific nomenclature *prorsa,* familiarly the "black-map butterfly" because of the resemblance of its checkered underside to the network of the latitudinal and longitudinal lines on the map. The *prorsa* flies late in summer and fall after the dog days. The other, *levana,* red, spotted with black, appears in spring after having passed through the winter's cold in the pupal stage. One day a naturalist demonstrated that *levana* and *prorsa* are really one and the same species, and that therefore one name, say *levana,* is enough for both. The difference in form is merely the result of temperature. If the glowing heat of summer acts upon the pupa, warming all its cells through and through in that particularly sensitive period, then there emerges a butterfly with black and white wings. If, on the other hand, the pupa shivers through the winter's cold, then the butterfly issuing in the spring is pale red with black spots. This was conclusively proved by experiment.

When pupæ of the summer generation were kept artificially cool in an ice-cellar with the conditions of winter reproduced, they, too, yielded the winter form, the *levana.* In this case it cannot be said that the cold really injures the butterfly. The winter and ice-cellar butterfly were just as strong, had just as much vitality as the others.

In fact, the species is even enriched in forms; which is always of value in evolution. Nevertheless, the cold produced certain modifications in the cells at a particularly susceptible period, causing the wings to assume a distinctly different colouring.

Extensive experiments were then made on other butterflies. Varieties of the "small tortoise-shell" from northern parts and from Corsica, long known in their natural state, were produced in large numbers under artificial conditions of heat and cold. Another fact was revealed.

You know the beautiful "tiger-moth." It comes from the caterpillar called "woolly bear." Its fore-wings are golden brown with white veinings like exquisite marble, its hind-wings cinnabar-red with bluish black spots. If you expose the creature to a temperature of eight degrees below zero, it will emerge a tiger-moth unscathed, but in some if not all cases the red of its hind-wings will be faded and besmirched, as if some one had rudely brushed it when still in the pupal stage. Select two butterflies with wings very much blurred, a male and a female, and confine them together so that they can copulate. What is the result? Some of their offspring have stained wings even though they themselves have not been exposed to artificial cold. The effect of the cold has evidently persisted to the succeeding generation. This is to be explained by the fact that when the cold acted upon the parents and modified the cells of their wings, the love-cells from which the next generation was to arise were already imbedded in the parental cell-colony. The cold penetrated to these love-cells also and produced such modifications in them as to result in moths with modified wings. You ask, "Are the future little baby wings in the love-cells so complete (being merely folded together so that they are miscroscopically minute) that their colour also, like that of their parents' wings, can be changed to the new tone?" By no means. You must not picture it so crudely as that. The love-cell is only a single cell, whereas the full-fledged moth is an aggregation of numerous cells. Nevertheless, there resides in the love-cell a certain power which produces all these later cells, hence also the wings. Our picture calls it the runic magic of the ring. In real cell-life this mysterious "something" lies in the chromosomes. Potentially some rune in the ring, some place in the chromosomes must actually contain the future wing. And the cold must have been able to influence this rune, this place in the love-cell, just as in the non-love-

cells of the colony it was able to influence the real parent wing. Imagine that a mystic rune W in the ring corresponded to the real wing in the colony. Just as the cold corroded and modified the wing, so it corroded and slightly but correspondingly modified rune W, and this modification then produced the stained wing in the growing new cell-structure of the baby moth. At all events, it is a very interesting case and offers food for thought. The real significance of the ideas it leads to will appear from the following:

It has thus been shown that the love-cells, notwithstanding division of labour, are not excluded from these penetrating influences, whether they be injurious as alcohol or indifferent as the cold to which the chrysalids were exposed. Fed from the same bowl as the whole colony, the love-cell, too, must swallow the poison that occasionally drops into the soup. It may very clearly be observed even in the human being how the eggs, the female love-cells, when still attached to the ovary, are regularly fed by special cells of the colony, which are not themselves love-cells. They are the follicle cells, in which the eggs in the ovary lie enveloped. These feeding cells extend their projections through those fine canals of the egg-wall or membrane which later enable the spermatozoon to gain entrance into the interior of the egg, and along these little pointed tongues the nutritive soup, which the special food department of the colony takes in for all, trickles through into the egg.

It will now be perfectly clear to you that it must have been impossible within one and the same system to guard against transferring influences, whether good or bad, to the love-cells. The love-cell had to have soup, it had to have heat. So it was impossible to seal it hermetically, to shut it off entirely from the rest of the colony, making it inaccessible to its experiences. The thing has never been done.

But there are other "experiences" that a colony undergoes which are just as necessarily all-pervading and penetrating.

Let us take one case to begin with. A volvox sphere receives a stab. A few cells far from the love-cells are injured. On the whole, the injury is immaterial, since the colony, in the division of labour, continues to provide everything that the love-cells require. Will this experience be reflected in the love-cells? Will it produce a corresponding injury in their rings and thus be handed down to the children and grandchildren? Nothing seems less likely.

In this case the love-cells cannot possibly share directly the experience of the few distantly removed external non-love-cells. In order that they should share at all in the experience, Fairy Utility (Darwinistically speaking, the preservation of the best) would have had specially to create a sort of postal communication from the injured cells to the love-cells. In this way the injurious experience would reach them indirectly merely as a secondary influence. Since the injury is something disagreeable and its perpetuation through the love-cells is by no means the "best" for the preservation of the species, but, on the contrary, unconditionally bad, then why should this special way have been established? If such a way happened unfortunately to exist, we should suppose that Nature would strive with might and main to destroy it. How is it conceivable that she should go to work for the very purpose of building one? What is true of the volvox globe is also true of the higher organisms. The larger, the bolder, the more complicated the many-celled structures grew, the more numerous were the chances for occasional injuries. If they were of an extremely serious nature, so that the whole colony died, then, of course, the love-cells died also. But a higher animal may experience many accidents without suffering permanent injury. It lacerates its skin and a scar remains, or it loses its tail, or, if a butterfly, a bit of its wing, or some of its colour powder. Life is a fight, and sooner or later every one gets a black eye. As for human beings, who of us as children comes off without a scar? Think of the blows a student gets in a football game, the gashes a German student receives in duelling, the wounds of a soldier in war. How many of us are minus a finger or so? The better our social organization for all of us, the better will a man with a wooden leg be able to get on in it. The better our surgery, the more people will be operated on. The surgeon removes the appendix and a piece of the intestines besides; he cuts out the larynx and saws at all the bones. Are all these damages to be inherited and perpetuated, all these defects and mutilations, the scars and gashes and wooden legs? Is a road to be built specifically for the indirect transference of the external cuts and gashes that the individual receives in the life-struggle to the rings of the love-cells, where, without such a road, the perpetuation of the pure, sound body was guaranteed through the old magic runes of the chromosomes? Granted that the intermingling of half and half of the chromosomes would bring "grace" to the rigid visitation of parental

defectiveness upon the children and would, moreover, eliminate a great deal of it. The blessing of sexual love is ever evident, removing the keenest edge from all these matters of life and death. Nevertheless one does not go to work to build an extra road for the conveyance of injury upon the vague expectation that some day or other it will gradually disappear.

The non-love-cells are subject to experience of still another kind, which you must not under any circumstances overlook. Start out from yourself as a cell-colony. Once again consider what a civilized man experiences in addition to poisonings and injuries. The most important because the best quality with which life endows you is outside those negative qualities. Your cell-body began its development through generation. It was so far completed in the uterus as in essentials to have all its organs ready to do their work at birth. Now the child enters the world, and immediately the world demands its work from it. It sets the organs about their business, making this one work more energetically and more frequently, and that one more feebly. Soon it is found that the organs, the special cell-departments, are influenced by the various demands made upon them. Vigorous exercise strengthens an organ; lack of it weakens it. See the muscles of an athlete's arms and legs. How they swell with strength, how work steels them. Compare them with the sorry, flabby flesh of a man confined to his room. It is not only crude strength that use so develops. Use produces nervous fineness and sensibility in addition. Consider the hand of a pianist. Constant practising has made a new thing of it, quick to act and responsive to the slightest pressure. We know, however, that the seat of these finest nervous actions cannot be said to be really in the hand or even in the outer eye or ear. The great central nervous organ of the brain-cell, which division of labour has developed into the most wonderful instrument in man, is behind it. There it is that the highest of all that is involved in the pianist's performance is heard, seen, acted and moved. The brain, too, is strengthened by assiduous use, all its machinery runs more smoothly and can perform its functions better with the proper measure of exercise. But this regular use of the brain gives rise to still another mode of life's reaction to external impressions. It is a splendid gift, and through it the brain learns an infinity of things.

Impressions from the surrounding world penetrate to it, and by

virtue of a remarkable property of cell-life it is able to retain these impressions. Roughly speaking, you may say that permanent scars are left upon it. No doubt, something physical does actually take place. The concept "scar" in this case, however, is much too coarse and conveys the meaning of injury; whereas the fine impressions stamped upon the brain are extremely useful. When the external stimulus that produced them is repeated, they awake, even if only a small part of the stimulus taps upon the same key. On reviving they in turn rouse other impressions once associated with them in time or otherwise. Suppose, for example, that a child underwent an experience followed by unpleasant consequences. He met a dog, the dog threatened to bite him. The next time he meets a dog he will recognize it, because of the impression upon his brain remaining from the previous experience. Instantly the recognition sets free the second impression that became associated with the first—"bite," "the dog is bad," "I must get out of its way." Memory and the inner association of memories are the two great magicians that make the puppets dance. It is with memory that the possibility of learning begins, later reinforced by numerous means, such as language, writing, education, and so forth. Think of all a civilized individual learns before reaching maturity. His experiences are not injuries but pure aids, means of protection in the complexities of life. It is through associative memory that the demands of the individual rise to the greatest heights.

Associative memory is by no means restricted to the human brain. Just as all animals have their organs strengthened or weakened through use or disuse, so, you will find, all animals are capable of learning by experience. You know what a dog, a horse, a parrot can learn in the course of their individual existences. The way they learn things evidently is quite the same as man's, and the advantage to them is the same as to man. If a dog has been stoned he will remember the experience when he sees a man pick up a stone, will associate this memory with the other—pain through the throwing of the stone—and will run away. Experience has taught him a lesson, which serves him henceforth as a warning of danger. In cases admitting of no doubt you can trace the evidence of the ability of animals to learn in this way as far down the scale of life as insects. Bees, it has been found, will gradually learn to know the very place where and time when something they like is regularly offered them. It was observed that when they leave their

hive to fly away for the first time, they have to impress its position and appearance upon themselves. Why should it not be so? Do not these animals, the dog in its way and the bee in its way, show strongly developed brains? In us the brain is evidently the special department in the cell-state for memories and associations. Why should not the same department reside in the animals' brains, when we so distinctly see, as it were, the government building in their cell-state, too?

Furthermore, our brain as well as that of the dog or the bee is in reality but a cell-department performing a special work of the whole colony. It is composed of cells and works for cells. If, as we have said, the various departments of the cell-colony represent at bottom nothing else than the original properties of the single cell distributed and specialized through division of labour (originally every single cell ate, moved and loved; now only a certain number in the colony eat for all, a certain number move all the rest, and so forth), then we must regard the brain-cells also as cells now exclusively engaged in work for the colony originally performed by every cell. It is true that as the brain cells of the higher many-celled organisms could devote themselves wholly to this single activity and did not, like the primitive unit cells, also have to move, assimilate food, etc., they could develop their particular specialty to the highest degree of perfection. Thus, at last, our glorious human brain appears as a true "multiplicator" (a word coined by a great biologist) in the art of cell-remembrances and associations. But the fundamental tendency of this development we must reckon as among the primitive characters of cell-life in general, and thus in principle—it matters not in what degree—of that of the dwarfs of our tale, the one-celled beings. Otherwise it would be impossible for us to say how and where in the scale of animal forms so utterly elementary a fact could have "originated." To divide the capacity for memory into evolutionary factors in the tree of organic descent is just as inconceivable as it is impossible to divide the other primitive properties of life, such as assimilation, excretion and so forth, or as it is impossible to divide the cell and its individuality. But where there is even the simplest capacity for memory there is also the possibility of learning.

Wherever the capacity for enhancement through use and learning existed, it must certainly have offered an immense advantage in conquering the obstacles of life and in promoting the self-asser-

tion and "happiness" of all organisms. Now the question is, would it not have been highly desirable, notwithstanding the extreme specialization (which the creation of the multiplicator brain so greatly furthered), to bring this advantage as far as possible into relation with the "immortality" of love by connecting it in some way with the reproductive cells of the colony?

In the unit cells learning was based upon the frequently recurring events of the external world. It is those events that lend a sort of regularity to life. Certain advantages, certain dangers that an individual meets with at such and such a time and at such and such a place always recur. The benefit of learning is that they are gradually conquered, so that finally the older and more experienced individual possesses them, as it were, he knows them in advance, he carries an inventory of them in his mind. The same is true of the strengthening of some particular organ through use. An organ grows stronger if the demands for its activity are frequently repeated. Now, it may be laid down as a general rule that what has happened to the adult will also happen, at least for a time, to the young, the children and the grandchildren. How great the advantage would be, how much of a saving, were the young generation to inherit the learning of their parents and the most essential strength of their organs and come into the world thus splendidly equipped.

To make this possible it would have been necessary to build a special road for this very purpose from the volvox stage up. If, for example, a motor organ of the colony grew particularly strong through exercise, then it as little affected the love-cells in the other far-away department of the colony, now so highly specialized, as did the scar from the students' duelling. It is true that during the parent's life the greater ease in movement proved advantageous to the love-cells also which the colony lugged along. But when the love-cells produced new beings on their own hook, their chromosomes, the hereditary rings, possessed no new runes engraved by the strengthened parent organ. They simply reproduced the organ according to the old traditions, and in the children the whole thing had to be done over again from the beginning. It was exactly the same with the brain in the organic forms in which specialization went so far as to evolve a brain. If the centre of memory, of learning, was now in the brain, then it was no longer in the centre serv-

ing the purpose of reproduction. If the brain learned, then the love-cells by no means learned with them. At first, all the learning done there on top passed, leaving no trace on their rings, and the new beings which they generated had to learn anew. Therefore to correct the disadvantage thus accruing from division of labour it would be necessary to build a new bridge.

But if the bridge were built, would it not open the road to the love-cells for every experience and thus admit the bad scars that the parents had received in the struggle for existence, the stabs, wounds, bruises, mutilations, the chopped-off ears and tails? Here was a dilemma. How do the one and yet leave the other undone?

Let us assume half in jest that this question was raised in the early volvox in a common council of the cell-citizens and that a heated debate arose as to which method to adopt and how to meet the dilemma in the best interests of progress. One cell in a well-considered speech argued in favour of constructing an absolutely free and open road from every colonial cell and its experience to every love-cell. Another vehemently opposed this plan, pointing out the evil consequences bound to ensue. Not only the useful but also the evil and the negative experiences, the wounds and the gashes, would be rendered "immortal." Finally, up rose an old sage cell with life-long experience and spoke words to this effect:

"Children, don't be hasty, don't act precipitately. Be cautious and avoid both extremes. Build the road, but make it an extremely difficult one to travel. In principle let the love-cells have a share in the experiences of every cell in the state as before, but reduce this share, say, to one per cent. In this way you will very considerably lessen the danger of the transmission of gashes and the loss of tails. Incidents of this kind, as you know, are merely accidental, irregular. Fed on such poor rations they will grow more and more fragmentary, they won't add up, but will completely disintegrate, and the counteraction of sexual love and cross-breeding will continue this process until all serious danger will pretty nearly disappear. It is true, at first the good cause will also suffer from the ninety-nine per cent reduction. But here, not as in the case of the accidents, there will be gradual additions which will make up for the loss. Since exercise and learning depend upon constantly recurring external experiences, there is a regularity to them. The son cannot go very far with one per cent of parent work and parent wisdom. But he goes through the same regular experi-

ences, and if he hands down one per cent of his acquisitions to his son, the grandchild will have two per cent. And so forth. Then, again, for all the justifiable avoidance of inbreeding, this general regularity is bound to exert some influence upon the male and the female, so that in this respect family intermarriage would be a positive factor for good. Finally, the distribution of the effect by slow additions in the course of many generations will in itself be a means to distinguish the permanent, enduring results of learning from the transitory results, which serve only the accident of the moment and are therefore useless to posterity. Only those experiences which strike the same key in many generations will in the end impress themselves firmly upon all the love-cells, will engrave a fixed new rune upon the ring. Thus, the purpose of the greatest utility will be served, all ballast will fall away, and there will remain only the material which time has certainly sifted. This last consideration is applicable even to injuries. Should it happen in individual cases of injuries that they have become the fixed rule through many generations, we'll say in a hundred thousand successive generations, every individual regularly had his tail chopped off, then I see no harm in having this transmitted and have each one emerge from his mother's womb without a tail. In the face of a calamity so persistent and continuous something must happen. Therefore it is best that we should of our own accord rid ourselves of the embarrassment—in this case the tail—and look elsewhere for something to atone for the loss."

This speech is illuminating. Although the real course of evolution was not decided by wise speeches and resolutions adopted at meetings of cells, but by the simple logic of force, according to Darwin's principle of the survival of the fittest or most useful, it is a matter of extreme interest and importance to know what law actually did go through at that time, and, as the final outcome of the whole problem, henceforth governed all many-celled beings with specialized organs, including man.

I have purposely introduced you to this subject by way of pure theory and logic. For as to the actual facts in the case, a perfectly satisfactory answer has not yet been found. In this matter, too, the history of love-life is still the ground of strong differences of opinion among the most honest and the most able scientists.

One thing is absolutely established. All the father's or mother's scars, gashes, and injuries are not necessarily inherited by the chil-

dren; nor necessarily all the parents' experiences, all their acquired memories, the strengthening of their organs through use.

Numerous cases among men as well as among the higher animals may be observed, in which the father or the mother has suffered permanent injury, which the child born subsequently does not inherit. The children of fathers whose faces are disfigured by scars received in students' duels may have no trace of scars on their faces. It is absurd to think that a dear little daughter will receive a few red stripes on her little nose and cheek as a dower from the former corps student, as Weismann once humorously remarked. This, then, is certainly not the rule. Circumcision is a very old custom, but as yet there is no people among whom the boys are born without a foreskin. That the son does not know Latin because the father learned it, that the daughter does not come out of her mother's womb able to play piano goes without saying. You may contend that the mixture in sexual union acts as a check, that the student's gashes are in their transmission to the child smoothed over by the mother's smooth cheek, that circumcision has always affected only the father's side, and that the father's knowledge of Latin may be outdone by the mother's ignorance of it. This last will raise a smile; and the contention is obviously inadequate. Among civilized races the overwhelming majority of children come from parents both of whom learned to speak. None the less the children are born without a knowledge of the parents' tongue. Systematic experiments upon animals have been undertaken with a view to determining the inheritance of injuries. Males and females possessing the same injuries were coupled. August Weismann, the brilliant zoologist just mentioned, experimenting with mice, cut off the tails in twenty-two successive generations. Of the fifteen hundred and two mice born of the tailless parents none exhibited even a trace of a defective tail. Granted that the experiment is not conclusive, since mice reach sexual maturity and begin to reproduce so very quickly; yet it proves beyond a doubt that inheritance of acquired characteristics is by no means inevitable. Accordingly, to use our figure again, the motion to open up the road entirely to both kinds of experiences was certainly rejected.

From this certain fact a number of modern investigators with Weismann at their head have drawn the further conclusion that there never was such a road at all, not even of the kind advocated in the so logical compromise motion of the sage cell. There is no

possibility and there never was a possibility, they say, of transmitting acquired characters, either good or bad, to the love-cells, whereby they should be perpetuated in the species; there never was a way for even partial, occasional, or limited transmission of acquired characters. Another group of just as keen and impartial scientists believe, however, that evolution did, as a matter of fact, follow that plausible middle course and that it is still following it to-day. Only a certain per cent of the good and the bad that the individual acquires is directly transmissible. But only those new characters will be permanently preserved and added up which numberless individuals acquire over and over again in a long course of time. External injuries, as being the most accidental and weakest, would thus be handed down as the weakest and most fleeting legacy, while the small but persistent effects of increased or diminished use and certain continually imprinted memories and mental associations would in the long run at least have the most favourable chances of perpetuation. This is an evolutionary process corresponding to about the maximum utility attainable, and is therefore theoretically, from the Darwinian point of view, the most plausible, if indeed we may assume that in the beginning of many-celled colonial formations and division of labour these things, too, were subject to the law of natural selection of the fittest.

Those who hold this last moderately positive view point to the fact that though injuries are not necessarily inherited in every case, in some instances they can be inherited. One must be extremely careful in one's observations. If a son has a birth-mark, one is easily inclined to attribute it to a scar that one happens to know the father has received. It may be, however, that the father also had a birth-mark, and it was this that reappeared, not the scar. The original appearance of the birth-mark in the line from father to son may have been due to something very different from the inheritance of acquired characters. Recall the figure of the rings in the dwarf tale. In the splitting of the rings a defect may somehow have "stamped" itself upon the very love-cells, producing the birth-mark. That is to say, there may have been an internal accident in the love-cells themselves, the effect of which would of course necessarily be perpetuated through heredity. If you wish to gather examples from experience, if you wish to investigate this subject and form your own conclusions, you must be extremely careful to avoid such errors.

The advocates of this theory are still more energetic in pointing out cases in which long-continued effects from use, especially mental experiences, that is to say, characters acquired by learning, have, all scepticism to the contrary notwithstanding, been transmitted to the offspring before our very eyes. The caution with regard to possible errors is of course no less applicable here. If a dog-fancier tells you that young hunting dogs come into the world with some trained characteristics, that is to say, that the acquired learning of their parents was transmitted to them, the very next generation, you will as a rule find that this is a gross error in observation. For a long time the dogs selected for hunting were those which from their birth possessed in a marked degree certain characters found to be useful; and the dogs thus selected were kept strictly pure by continuous breeding. No wonder that to-day the good hunting dog begets young with the same good characters. They are the expression of the extreme purity of the race and its instincts. Now, where these instincts were first acquired as "learning," we cannot tell. It goes all the way back to the unknown, and the opponent of the theory may say that it is a primitive individual character of a part of the dogs, or that it is one of those "stamped" defects that accidentally got into the love-cells, an individual defect stamped upon the rune of the brain in the ring. Man happened to be able to use this defect to his advantage, and so he picked out the dogs that had long had this accidental capacity and kept their breed pure. But the dog possesses the further capacity to learn something as an individual, which capacity man utilizes. This personal acquisition by training is never inherited. What is inherited are only the old fundamental characters of the species. It is true that by reason of his racial characters the young dog is predestined to be an excellent subject for training, thus creating the impression that the learning its father acquired descended to it, whereas, in truth, it is only the characteristics of the old celebrated race asserting themselves.

You see what extreme caution is necessary to check up your observations. But this should not deter you from going ahead impartially testing and investigating for yourself that still open problem of love-life.

For myself I believe that the question will perhaps be solved most surely by close observations of the human brain. He who has impartially and frequently observed the development of children

from infancy to school age will scarcely fail to conclude that an extraordinary amount of hereditary material plays a part in their development, apparently a far greater part than is commonly supposed. At every step in the child's education, especially in its early years, we seem to feel that even when it learns anew, peculiar internal agents are helping it on. In me this has always produced the impression that a large part of the child's learning is but an inner awakening. My previous statement that no child learns to speak through heredity without external aid is quite correct. But it is also true that the extreme rapidity with which as a rule our children learn to speak would be the greatest miracle, were the external aids not reinforced by some inherited tendency of the brain. Later, usually at about school age, we observe striking talents for special subjects. Give a class of boys and girls all the same instruction in mathematics, music, and drawing. In some you will encounter little brains and hands into which every slightest point of the subject must be drilled as if the matter were entirely new. In others you will find that after the first stimulation learning proceeds as smoothly as if it were nothing but a recognition, a revival. My own experiences have pretty nearly convinced me that a gift for style, which in some of the children's compositions crops out so early and unexpectedly (sometimes fairly appalling the teachers, who have been drilled into the routine for the average pupil) is an inherited characteristic which sets in impulsively the instant opportunity releases it. Careful investigation of this subject (an excellent field of study for teachers, who complain of the tedium of their profession) may lead to instances establishing the starting-point of these hereditary transmissions and thus, perhaps, enabling us to connect them with the former acquisitions through the learning of the forefathers. Let us say—the example we choose is immaterial—that we chanced to discover so specific an inherited tendency of the brain and hand as talent for a particular musical instrument, the piano. No child can play the piano without learning. Heredity never goes so far. But perhaps the talent for piano-playing will show itself in a very high and peculiarly characteristic degree, just as some children display a talent for prose composition or mathematics. Now, the piano is an invention of historic times. The technique of it certainly has been acquired only within historic times. The boldest skeptic will not maintain that there was a

special race of men in ancient times, before the invention of the piano, with an especial gift for piano-playing. A single positive discovery of this nature would make us sure of our way in this great matter as far back as the primitive beginning of Volvox. The story of love-life is here a practical problem for every one. At all events, one fact observed in mental inheritance has already shown itself to be of value for our subject.

The very manner in which these inherited mental characters revive bears a remarkable inner resemblance to memory processes.

An external impression produces (physically also, as previously observed) a memory in our brain. The memory persists even after the external cause has passed; but it does not remain permanently active, at first entering into a stage of rest. If the external cause were never repeated, it would remain permanently dormant. But as soon as repetition knocks at the door, it wakes up and becomes active as a genuine "memory." The characteristic thing about a memory is that in order to bring about its activity the cause need not be repeated in full. Let a mere part of it, a mere association, touch the brain, and the whole awakens, it comes back to us. We have seen a man. He remains in our memory. We do not meet him again. We merely hear his name, or meet somebody slightly resembling him, or we hear his favourite tune, taste his favourite dish. At once the memory awakens. With our mental eye we see him again.

The same is true of inherited mental characters. The mathematical gift, for example, is at first but latent. It slumbers. If its possessor never became acquainted with mathematics, then it would never awaken in him. But the external stimulus comes, and immediately the inner chord starts vibrating. If the gift for mathematics is present, the stimulus need be far less than in the individual without the inherited character, in whom the whole must be newly engraved from the start, while in the talented person the slightest impulse releases the latent force, just as a spark is enough to explode a cask of powder. If you take the trouble to examine the subject closely, the analogy is striking. A brilliant scientist, Richard Semon, has recently attempted to trace this analogy with awakenings of memory in all hereditary processes. Beginning with mental heredity he has pursued the subject down to the formation processes in the egg and the embryo, which, of course, are all doubtless based upon heredity. He has very ingeniously shown how here,

too, heredity displays a startling analogy with the mechanism of memories, the processes of recollection. Semon comes to the conclusion that at least in so far as the physical foundation of the two processes is concerned there is more than a mere analogy or similarity, that the two processes must indeed be identical. The love-cells build up the new being, the new many-celled colonies, in accordance with laws which we may, in a strictly scientific sense, designate as laws of memory.

This assumption to which I can find no valid objection, will assuredly make it easier for us to conceive the road that may have laid itself out from the mental processes to the processes in the love-cells. Memory processes in the brain would find an echo in memory processes in the love-cells.

As to the road, if indeed it ever formed, there has been much controversy. Weismann, in combating the transmission of acquired characters theory, was of the opinion that the impossibility of imagining a road is in itself an argument against the theory. As a matter of fact, the difficulty of conceiving a road has led even the upholders of the theory to many bold hypotheses. Darwin, who believed that acquired characters are transmitted from the non-love-cells to the love-cells, had in mind a sort of live postal system. According to him every cell of the colony throws off during its lifetime imperceptibly minute, animate granules or gemmules containing the chronicle of their experiences, their learning and their changes. These little pieces of mail matter heap up in the love-cells. It is evident that this hypothesis, called "pangenesis," practically does away with the functional difference between love-cells and non-love-cells. All the cells of the colony, by virtue of their splitting off parts of themselves, are shamed-faced love-cells, while the real love-cells are merely a principal post-office station where all the separate products are collected and arranged. The parts split off from the various cells must always be dispersed throughout the whole body; the true love-cells must have the capacity to seize them as they pass and hold them.

Since the particles can be imagined as small as possible, Gustaf Jäger, the eminent, resourceful biologist, has volatilized them to exquisitely fine, imponderable scent stuff. According to him, each cell gives off its characteristic scent. These scent stuffs in turn have the capacity—I never fully understood how—to build up cells with all the experiences embodied in them. Hence the work that

the egg-cells and the sperm-cells do is merely to collect and catch the smells.

But perhaps these and similar more or less ingenious theories are more complicated than need be. In reality all the cells of the colony are united. Consequently the love-cells, before they mature, form a close union with the rest of the body. All the external influences reaching the body at any one point can, therefore, finally spread through the whole cell-colony by setting up vibrations which are propagated throughout the body, and thus, finally, reach the egg-cells also. For example, every impression photographed upon the brain as a memory, can, if need be, pass on through the whole nervous system in some form, even though weakened, and from there continue its vibrations to the remotest department of cells. If the love-cells, too, possess in an especially fine degree the capacity of living substance to stamp such memories upon itself, then the matter is in the main explained. But of course in such sensitive, distant sympathetic vibrations it would as a rule require a long accumulation of similar stimuli in order to produce a perceptible memory impression in the love-cells.

All in all, it is not so much a matter of finding a special way, say from the brain to the egg-cell, as to make the egg-cells so sensitive and in essence so like the brain that in some attenuated form it feels all the influences affecting the brain. If this be so, there is no doubt that the example of the tiger-moth is approximated, in which the cold affects and modifies the wings as well as the love-cells. The example of the tiger-moth further solves in a purely matter-of-fact way the question whether the egg-cell or the sperm-cell contains the brain of the future child, storing up memory impressions for it, as it were. The brain itself does not as yet exist, no more than the future wings of its young exist in the woolly bear, the pupa of the tiger-moth. But in connection with the tiger-moth we used a figure by which the thing that is modified is a hereditary rune W in the ring. Here the thing that is modified is a rune B, to which the respective parent part of the brain in the child corresponds.

Though we grant, as we no doubt must, that the entire subject is not perfectly clear, yet we gain insight at least into possibilities, and no harm is done if once in our story of the evolution of life, we distinctly refer to the fluctuations in the conflicting opinions of scientists. The views I have cited are not all firmly established as

rocks. Let us have some of the joy of the hunter in running down his prey. Let us hunt the timid game of truth. Hunting is very much worth the while if only for the pure air we breathe in roaming the fresh forests, camping under the sky amid Nature's primitive glory.

One thing remains to be said, that very important conclusions as to the tempo of the general evolution of higher organic life depend upon whether we assume that acquired characters are or are not inherited. If direct changes of organs through use or disuse are at last after so and so many cases effectually preserved in the "immortality of love," though by a process of fragmentary and slow accumulations, and if the effects are thus perpetuated in the grandchildren and the great-grandchildren, then evolution in the sense of progressive adaptation and increasing subjugation of the outer world must have taken place much more rapidly and consistently than if there was no such gradual process of transmission. In the latter event the organisms would receive from the propagating cells only the same old primitive material for meeting the new demands of life, with the addition of variations which at first are merely accidental products irrespective of whether they are good or bad for the life-struggle. These variations would produce the original individual characteristics of the "ring" and further that oft-mentioned "stamp of defect," the neo-formation in the cross-fertilization of sexual love, and occasionally one of these penetrating poison or temperature modifications as a "corrosive" of the ring. From this material, which at first is perfectly indifferent to progress, Darwinian natural selection would choose some and weed out others; for to meet the demands of the outer world Darwinian selection allows only those generations to survive in the long run which are equipped with useful variations, while exterminating those that are useless in the struggle for existence. This method, of course, would be far more indirect, tedious and uncertain. In the other method natural selection would act merely as a ready agent in eliminating extravagances and keeping the road from swerving from its direction. Without the inheritance of acquired characters the road would have had to build itself painfully and laboriously. The theory of a rapid tempo in evolution leans toward the older doctrine of Lamarck, while the other hypothesis is hyper-Darwinian going farther than Darwin himself ever went. Weismann, its chief representative, has very ingeniously invented a number of subsidiary hy-

potheses to supplement it and thus secure a somewhat greater guarantee and trotting-pace to evolution. But from our point of view, it would be superfluous to enter into details.

The subject is of extreme importance to pedagogy. With the progress of civilization, will education be able to work upon every sort of human material, in the end making itself felt in the whole race and raising the whole race to a higher level? Or will it continue merely to uplift and support the individually better variety promoting natural endowment to the highest degree, while maintaining the individually worse variety upon at least the highest plane to which it can attain? In other words, will education remain practically inactive in relation to real progress, leaving progress to the self-assertion of individual talent and so to general natural selection and its highest products? This question the theories of evolution have not yet solved. In fact, one may say that the very solution of the evolutionary theories in a certain sense depends upon the experiences and results of pedagogy. What is needed, therefore, is steady, persistent pioneer labour.

§ 5

Let us pick up the thread of Volvox again. The great line is now perfectly clear to you as a whole—from the earliest being, only a single cell containing a nucleus neither male nor female, which for the act of multiplication merely divides itself in two halves, to the higher organism consisting of a community of many cells combined into a single individual (wonderful is the way!), which through division of labour is separated into special organs of cells and which possesses one organ for the exclusive function of propagation regardless of the relation or non-relation of the function to the other cells of the body; an organ, moreover, either male or female, from which either single sperm-cells or single egg-cells escape; sperm-cells and egg-cells which in the strictest avoidance of inbreeding coalesce in the act of generation; and from the union of which through "propagation," actually commencing in the real sense of the word only after the union of the two germ-cells, a new being arises. In regard to the origination of a new being we must now add a final word, which though again touching the ticklish problem of inheritance strikes it at a more harmless point in its path.

Carefully examine and compare the two series of processes. Here is a volvox mass, or a somewhat more advanced, but in principle similar community of cells. What is the evolution lying behind it? Several stages. At one time there were nothing but one-celled beings. These evolved up to the stage when they sought each other two by two, a motile small cell and a quiescent large cell. They coalesced and produced from themselves by division a group of new unit cells. Through a long period of time progress may not have reached further than this point. Then came a new stage of evolution. Many unit cells combined into a joint social community, in which the first division of labour took place. Some cells assumed for all the others the work of multiplication. Henceforth they alone in the cell-sphere divided into male sperm-cells or female egg-cells.

In the foregoing you have followed this process yourself. Though, to be sure, it does not mark a world-stirring line of evolution, yet it is a piece of history which must have occupied a con-

siderable period of time, even if the course of evolution followed the more rapid tempo. And certainly it must go back to very ancient days, far beyond the time of even the Algonkian-Cambrian shore.

Again consider Volvox. Dismissing from your mind all history, all primitive becoming and evolving, take the little cell-sphere merely as a small individual creature of to-day, under this your sun, in whose golden net you, too, are woven. Take it as a little tiny point now merrily gliding under the crystal blue surface of the water. How did the little creature "arise" as an individual in itself? A relatively short time ago it was still a single cell, an inert egg-cell. To this single cell came a still tinier single cell, a motile, free-swimming sperm-cell. The two coalesced, and the new individual, in its turn, produced from itself by division a group of new single cells. This group remained together in a social community, our volvox sphere. A certain division of labour arose, which will lead to the division of some cells into egg-cells, thus introducing the circle of propagation again.

Yes, these two processes, the one so old that presumably it went on in the pre-Cambrian epoch, long before man's emergence on earth, and the other quite new, still recurring before our very eyes —are not the two processes alike?

They are alike in the stages they represent. Each volvox sphere to-day still undergoes in its individual development precisely the same little series of processes and phases which appeared in the earliest days, when for the first time Volvox evolved historically from the primitive one-celled being.

There is only one positive difference. What takes place in the volvox sphere to-day very rapidly and smoothly, just like the unwinding of a watch-spring, must in olden days, in the first course of evolution, have appeared very slowly, bit by bit, in an extremely long sequence of generations. It must have been a slow, very slow process for that original sequence of generations to find each stage upward under a thousand complications, attempts, selections, hindrances. Slowly, very slowly, one generation after another had to discover of itself each single step and test its utility. The volvox sphere of to-day evidently stands in relation to these old generations as one who is secure and assured in his possession.

You may interpret this variously, according to the view you take of heredity. You may simply say, as if you were considering a dead object, that in primitive times, a permanent structure had first to be

formed very gradually from a confused play of balancing forces; but that now the weight of the clock properly set sinks regularly while controlling the entire clock.

Or you may regard the single cells in both cases as living beings and say that in the primitive organisms quite definite instinctive actions (for example, the seeking of the two cells for fusion, or the remaining together of the sister cells, or division of labour) were at first somehow implanted in them very gradually; but that in the present volvox globe these instincts follow one another in regularly selected order, one liberating the other.

At all events, as has already been said, the present smooth course of events in its inner regularity strikingly resembles a memory process. A definite weak stimulus releases an equivalent of the old historical processes in exactly the same way as a memory arises in our brain. Thus, the fusion of the sperm-cell and the egg-cell is evidently the external stimulus that inevitably and immediately causes the splitting of the fused cell into many cells, that is, the formation of the cell-colony. In animal eggs not yet fertilized it has been found possible to replace the stimulus by artificial means, magnesium chloride, sulphuric acid, or, indeed, simply vigorous brushing. The cell thus artificially stimulated begins to divide. The traditional rule, of course, is that the mixture of the two nuclei is the immediate impulse causing this activity. But just as memories can be induced merely by a substitute of the old impression, a sort of echo, a word, an odour, so in the artificially stimulated egg-cell, too, some such echo seems to suffice. Perhaps the chemicals recall the smells of the sperm-cells; perhaps the brushing imitates the tremendous stir and whirl of the nuclei, of which I told you. Of course, the substitutes can never possibly replace the real essence and purpose of the act of fertilization, the half-and-half mixture of the chromosome parts of two individuals, though they can imitate sufficiently well the signal for the action that immediately follows this mixing.

The division producing the colony acts as a stimulus to release the next definite stage; which is the form of a hollow pouch. The hollow pouch, in turn, is followed by the next step released, division of labour among the cells. This releasing of one stage after the other resembles a chain of memories, where one association arouses another. The sequence in which one stage awakens the next is determined by the primitive historical process. What once stretched

over a long period of time now unrolls itself in the briefest period on the thread of memory, firmly fastened, nevertheless, to the thread of sequence.

However you may regard this, whether as a significant mental similarity, or, if you are cautious, merely as an agreement in the material basis of the two processes, at any rate, we will adhere to it, that the individual processes of to-day and the historical processes of the past stand in precisely the same relation as an actual chain of events imposed from without stands to an inner chain of memories. The instant Volvox of to-day releases its love-cells, they fall in the spell of the inner chain, as irrepressibly as a clock wound up and jarred to set it going.

Now try to embody this simple fact, which the volvox teaches, in a principle, a "law."

You will have to allow that every single volvox sphere of to-day in its individual evolution once more passes very quickly and with automatic certainty through the old sequence, the same evolutionary stages that its ancestors once passed through historically when they evolved into volvox.

From the whole course of things as I have presented it to you, you see there is no witchery in this "law."

But mark now, this law has furnished you with a key to all the facts of evolution in the love-life of the higher organisms on earth.

By the aid of an extremely simple case you have yourself discovered the so-called "fundamental law of biogenesis."

It was Haeckel who first evolved and named it. He joined the two Greek words *bios,* "life," and *genea,* "descent." He uses *genea* in the sense of history of evolution. The word therefore means the fundamental law of the historical evolution of life. The facts underlying this law had already been effectively pointed out before him by Fritz Müller, and there are glimmerings of it as far back as before the time of Oken. Its final formulation is found on page 500 of Volume II of Haeckel's *Generelle Morphologie* (1866). Haeckel calls the science of the more or less primitive actual chain of events in the history of all the animals and plants of to-day "phylogeny," or tribal history (from *phylon,* Greek for "tribe," and *genea*); and the branch of biology dealing with the development of the individual, which in its neo-formation each time repeats the chain of memory, "ontogeny" (from the Greek *onta,* "individuals," *genea*). The law signifies that in its fundamental course ontogeny

is a brief rapid repetition in the development of the individual of the course of phylogeny.

In the development of the individual of every present species of plant and animal! Hitherto we have exemplified this law only in Volvox as the simplest case imaginable. The generalization adds a vast deal to its significance, embracing all organisms, the animal species man included.

After so many times I must again ask you to return to the simple story of the human egg-cell and sperm-cell, that capital story with which our love excursion began. I told you that upon it rests one end of the great rainbow of love arching over our old planet. Now you bring a key to it, the last magic golden key.

You yourself, with all your myriads of cells, with your organs in which the cells perform special functions, are, as you have learned, but the most glorious and highest product of that evolution which began in the volvox cell-sphere and its like. Whatever the distance that separates you from Volvox in intellect and the highest human qualities, all your most important fundamental properties were, in a certain sense, already potential in Volvox and later in the gastræa: cells closely united into a social community; division of labour leading to the formation of organs; among these organs, above all, reproductive organs, in you male, in your sweetheart female.

To be sure, between you and the gastræa or volvox there is a tremendously long chain of further historical developments. The first volvox globe and the first gastræa on your tree of descent are removed far before the Algonkian-Cambrian shore, which is itself removed from the present by many millions of years. The gastræa after many transitions (we will consider this historical course in greater detail later) became a worm; the worm, the earliest, simplest vertebrate, somewhat like the present primitive fish-form amphioxus, the amphioxus, a fish suggesting the lamprey; the lamprey, a fish like our shark; the shark, a mud-fish; then a salamander, a reptile, a mammal related to our ornithorhynchus, a marsupial; and later a half-ape, an animal resembling the real ape. At last came man, who fashioned civilization out of nature in the red glow of the hearth fire which he artificially created.

A huge chain of evolution far exceeding in length that little sequence leading from the earliest one-celled beings to the volvox ball, or the gastræa yet, in its fundamental character, the same. Throughout the long chain nothing of a different nature was added. Volvox

fulfilled the fundamental law of biogenesis, and so does man. You fulfilled it when you were in your mother's womb; your child, which you begat from your body, fulfilled it.

In your wife's reproductive organ a single tiny inert egg-cell detaches itself, a single cell. Through your agency in the love-act it is joined by a still tinier cell, a motile sperm-cell. The two coalesce (you had a clear view of the little mystery) and through fission produce from themselves a group of new single cells, which remain joined together in a social community; and division of labour, through the arrangement of definite cell-groups into organs, arises in the community.

Now mark, man is no longer a volvox, and yet in the womb he also repeats the whole line which the individualized volvox organism recapitulates according to the fundamental law of biogenesis. He must perforce do so, for historically he has advanced beyond volvox, or at least similar forms. His existence on earth comprises within itself that of volvox as an early stage of evolution.

But he does not stop at the volvox stage. The human embryo in the womb comprises still more. In conformity with the fundamental law of biogenesis it must pass through additional phases, because man's historical evolution once rose beyond Volvox up that huge ancestral ladder from Volvox to yourself. You see how the embryo grows from a simple mass of cells to a structure consisting of several layers of cells, just as the gastræa acquired two layers of cells, skin and intestine. From the cell-layers, organs are formed resembling a worm's. The first rudiments of the spinal cord, of the simplest vertebral column still without a skull, becomes apparent, as in the lowly amphioxus, which lacks a skull. Then the skull forms, at first as in the jawless lamprey. The two pairs of limbs appear as finlike buddings. Gill-clefts open at the neck. It looks as if the thing were about to turn into a fish; but the extremely rapid automatic development straightway turns off to forms in one respect and another recalling the amphibian, reptile, ornithorhynchus, and marsupial. For a while the balance seems to waver, so that it is a question whether the embryo will turn out ape or man. Then the last doubt vanishes. It is a human child. Thus you came to be, thus your sweetheart came to be; thus each of your children will come to be. Every man, the king and the beggar, Spinoza and Hieronymus Jobs, the saint and the criminal.

Once again you become what you were, what your ancestors were.

As you "become," that is, as you detach yourself as an individual from the huge tree of mankind, your own development again tempestuously whizzes through the whole line from the bacillus to man. To be sure, in many respects the development proceeds too rapidly, so rapidly that whole phases appear blurred as in a haze. The way is too tremendously long. Even at the maddest gallop all the stages cannot be covered. Some of them are skipped, obliterated. As Haeckel justly pointed out when first enunciating the fundamental law of biogenesis, the history of the embryo, especially in the higher and highest organisms, is not an exact recapitulation, but rather a suggestive epitome of the history of the race.

This very fact, however, shows a peculiar similarity between the development of the embryo and the processes of memory. Our memory, too, always inclines to a disarrangement of the progress of past events. It abbreviates, condenses, and interchanges, omitting certain series, shifting the cues, as it were, and pushing a former event to a subsequent position and the reverse. One always has the feeling that it is not a dead cylinder with written signs, but that it lives in a brain constantly undergoing a thousand processes, and that it is forever taking part in the life of this brain even after the first impression has been made. In precisely the same way the embryo has gone through various fortunes in the course of its history, and often in the organic life of the species has had to adjust itself and yield to them. Since the "disturbances" resulting from adjustment to these changing fortunes seemed too striking, the word "law" was frequently called into question, the exceptions being so many that it seemed inappropriate. But it appears to me that in principle it keeps its meaning here, and that we may speak of the fundamental law of biogenesis in the same way as we may say that the fundamental law in brain memories, notwithstanding the many faults of memory, is the reproduction of experiences that have once impressed themselves upon us.

There is another most singular resemblance between the brain memory and the development of the embryo. In each the earliest impressions are the most permanent and complete. Later many impressions shove themselves one on top of the other and scribble over the others' writing. But the first stages remain clear and sharp, like the first fair copy in large letters on a clean white sheet. And exactly like the memories in the brain, so the earliest pictures in the development of the human embryo, from the first cell to the cell-sphere, rise

up as sheer and firm as rocks. Later much is done more negligently. Yet on the whole, for him who comprehends the meaning of it, it is a magnificent restoration.

One must be able to set the proper estimate on things, to separate the wheat from the chaff. Therefore you must not regard as part of the biogenetic law of recapitulation the rules which nature later adopted for the protection of the young animals, the egg, or the embryo itself. The fact that the young bird matures in the shelter of a hard calcified egg-shell must not be taken to mean that its ancestors at one time were all their life long encased in a hard chalk shell. In the butterfly the wingless larval caterpillar, elongated like a worm, may in some of its features actually repeat an ancestral phase. On the other hand the protective cardboard case in which the transformation from this stage into the real butterfly takes place is certainly no repetition of racial history, as the natural philosopher, Oken, in the first anticipations of the biogenetic law, supposed. Oken thought that in the chrysalis case the hard-skinned crayfish, the alleged ancestor of the insect, emerged once more. But this is quite impossible. On the contrary, we should expect traces of the law to be most clearly indicated where the arrangements of this nature have ceased to be useful, and yet where the embryo or the young exhibit striking peculiarities entirely absent in the grown-up animal and for which the embryo has no direct use. Thus, the embryo of the giant baleen whale forms true hard teeth in its jaws, while the mature whale shows no trace of teeth whatsoever, the celebrated whalebone in its mouth not being teeth, but horny palatal plates. The teeth are of no direct use to the embryo either, since they form while it is still in the mother's body and disappear before birth. But since whale-like mammals with permanent teeth, which they use, are still in existence to-day, and since the oldest remains of whales from the early Tertiary period, which anatomical considerations lead us to believe are the historical ancestors of the baleen whale of to-day, also had teeth all their life long, we may conclude almost with certainty that the embryo teeth of the present whale are a repetition of an ancestral character in the truest sense of the fundamental law of biogenesis.

Now at last you behold the whole mystery.

Do you understand now why I have taken you to the Algonkian-Cambrian shore and still farther? Do you see it emerge—that shore, and the jurassic shore, where the primitive mammals and the mar-

supial lived, and long before these, the primitive shore with the gastræa, primitive volvox, and primitive single cells—do you see them emerge in the magic dark purple of the human mother's body, still governing the things of the deep dark earth from which man springs?

PART IV

THE KALEIDOSCOPE OF LOVE

In the mother's womb e'er waiting,
Lovely queen of field and lea,
Silent, great, all-animating
Nature carries thee and me.

HÖLDERLIN

§ 1

Right in the midst of time,
The new Divinity
Becomes what ne'er it was
In all eternity.

ANGELUS SILESIUS

THE pine forests of Brandenburg in its summer solitude. You are lying full length in the fern, gazing up into the silken blue sky through the clearing along the railway embankment. Far and wide nothing but woods, the rough seamy russet of tall tree trunks. Above, the greyish green web and woof of the pine needles, mottled by smouldering bronze flecks of sunlight. Under your back another little fairy forest, the hard green lacework of bracken spreading along the ground in an immense carpet. In the depths of the woods a quivering golden-grey haze, the very essence of heat.

You lie there and think. You think of the soft voices and the life of the forest, scarcely audible, yet beating and pulsating. Life, life everywhere. The animal world. The plant world. Here and there a finch calls softly in the bushes. From away beyond comes the cry of the cuckoo like the dying-away of a bell. A swallow's white breast suddenly flashes against the strip of blue sky. A squirrel darts across the bracken green from one russet column to another, like a loosened red patch. Close at your ear you hear a delicate crackling. A long brown procession of ants is marching by. From its little white funnel in the ground a grotesque insect, the ant-lion, throws sand after the paraders. In the fern a bumble-bee, hairy as a bear, is droning. In the shimmering haze in the depths of the woods, there is an incessant coming and going of other insects, like the heaving and tossing of bright golden specks, with here and there the gauzy silver thread of a cobweb waving between.

Your view encompasses infinite worlds of life. You who are lying there are a part of that life, inseparable from it. It is but one great wave of life on earth—pine and bracken and insect and bird and you, all rocked by the same law, steeped in power by the sun, about which you on your old earth are revolving, children of the light,

cradles of the spirit, brothers from the beginning of the planet, joined together throughout the primal millions of years, yet arriving at different goals by changes of route in journeying, pine and bracken, ant, swallow, squirrel, and man.

You are all children of this globe, closely united by that very fact, children of the great islands around which the blue ocean rolls, which is the real primitive earth. As you are now gazing up at the sky it is as if it once more, with ethereal clearness, mirrored those wide expanses of water which the forest hides from your sight. The waters, too, teem with life, trees rising from the coral depths, covered not with green leaves, but with the greedy orange-yellow mouths of polyps, darting silvery fish, and a long procession of bells, the medusæ, sparkling in rainbow hues, the most fabulous of all the children of the deep. Life, life in the sea as on the land. There is a world in a dew-drop, myriads of quivering souls, and everywhere the longing one for the other, the pine and the fern frond, and the finch and the ant-lion, the swallow and the squirrel, the silver fish and the large variegated iris of the sea, the medusa, all love, just as you dream of your sweetheart. All is one vast chain of life, one vast chain of love.

Press your head to the granite rock near by, which glaciers of the ice-age once dragged down here from far away in Sweden. The old legend:

"And Jacob lighted upon a certain place, and tarried there all night, because the sun was set; and he took of the stones of that place, and put them for his pillows, and lay down in that place to sleep. And he dreamed, and behold a ladder set up on the earth, and the top of it reached to heaven: and behold the angels of God ascending and descending on it."

The naturalist of to-day touches you on your forehead, and for you, too, a ladder rises to heaven.

Man is the heaven of the earth. He was the first consciously to see the golden heaven of stars above it. He has built himself a home in a super-earthly firmament of the spirit. He has created God in art, in ideality, in goodness, in truth, in himself. Up to this creature man reaches the tremendously tall ladder of the other creatures that have come to be. Form after form of the living as well as the extinct ascend and descend on it, all the organic forms lowlier than man. A huge tree of descent, O Modern Dreamer, is your heaven-reaching ladder, sprig on sprig, branch on branch.

At the very bottom is the primitive cell, the first living thing, as yet neither animal nor plant. Then the cell-communities as you beheld them in Volvox, in the one case climbing up to the plant, the fern, the pine, the hazel of this forest; in the other case, through organization into skin and stomach, through a definite division of labour of a different kind from the plant, in conjunction with a different mode of eating and breathing, to the gastræa, the primitive stomach-animal, with mouth, stomach and skin. And above the gastræa the whole multifarious animal kingdom, one ladder next to the other, and man with the radiant eye of Goethe towering on the highest rung of the highest ladder.

Gird your loins. We shall now climb up the animal ladder above the gastræa.

The oldest forms again sink beneath us in the midst.

But hard by, the immeasurable parallel ladder of the plant-world also disappears in the twilight.

A deep gulf separates the higher plant from the higher animal above Volvox and gastæa. For its upbuilding the plant, at least by day, takes in carbonic acid from the air and gives off oxygen, the very element that is indispensable to the animal for breathing. With its roots in the soil it works up the mineral substances directly into its own substance. This the animals never do. The animal cell for its continual renewal and growth requires substances that have already been elaborated organically, whether animal or plant substances. Though radically separated from plants in their tree of descent, animals thus seem to be dependent upon plants for the very conditions of their existence, though this does not make them the lower, but, on the whole, the higher members of the organic world. Animal life no longer requires the depths of the earth and its darkest living spirits, but bright life itself, life already organized. From the animal in its highest development arose man, who, spiritually, is higher than the animal by as much as the animal is higher than the plant and the plant higher than the earth.

In its love, too, the animal unmistakably reveals this higher principle. For the way from the animal leads to man, with whose love it is that the top stories of love—human love, universal love, the love created by art—clearly open up for the first time.

We will now proceed along this particular path very, very slowly.

By the fundamental law of biogenesis I have shown you how man, how you yourself, and, through you, your sweetheart are still directly

connected with the earliest process of the evolution of organic life on earth. It is this very "earliest" part of your love that naturally seems most important to you, since it embraces the entire act of reproduction and its immediate consequences. Nevertheless, do not forget that the proof of this connection, this explanation, by no means exhausts the theme. In fact, it merely posits it. You now see the great primitive line, but no more. We have a new task before us. Between gastræa and man there is the incredibly huge series of higher animals with their thousands and thousands of love-forms. All have something in common. So much you can now perceive in every instance. But the multitude of variations on the one primitive theme you by no means know. And yet it is from all this that man has grown as a great, fabulously wonderful single instance.

Our next course will no longer be to follow a fixed straight line, but to observe kaleidoscopic, individual pictures, as it were. They portray on the wing the whole animal kingdom, although with dream-like rapidity, and a system only intermittently shining through. A streak of light here and there. We shall return to man, do not fear, and then resume a uniform course.

Prepare yourself. Sometimes you will feel as if you were passing through hell. But it isn't hell. It is a quiet journey through old places, back to dolls' trunks in your own sunny world. Some are places in which you yourself once lived, others are in the neighbourhood with the old household goods unchanged. Have you not had some such experience before, when as a young man with the first down on your lips you returned to the home of your childhood? How quaint and strange and small and dusty all the old furniture looked! Many things seemed so foolish, so childish and naïve that you had to laugh, you who had come back from so many hot world-suns and so many star-journeyings. There were the little old gossips, in the confinement of whose rooms as they sat over their tea and faded embroideries of the year so and so the world stood stock still, unmindful of Copernicus, Darwin, and the social problem. You smiled. You understood, and you were touched. Here your youth spun the threads of the first love that came and went. At that time it by no means seemed so ridiculous.

It is in this way that you are to look upon the animal world, the medusa, the crustacean, the ant, the starfish, the fish. They are the old gossips to whom you, the child of the great world, return in a quiet twilight hour. The child of the great world returns to the

tiny old dwarfs that rocked it in its cradle. You are thinking, and your thoughts turn into a large, quiet mysterious veil of roses, which blossom and send their thorns over all love that has died away. Between the rose flames are the eternal stars. There is no corner on the earth where they are not, and from their milky ways the song of the world sings of the spirit:

"And behold I am with you all the days unto the end of the world."

§ 2

Imagine a plum with a hole at one end, a mouth leading into a hollow cavity inside. The wall around the cavity consists of two skin layers, and the outer layer has two tips or little hairs. The plum falls into the ocean, the little hairs begin to move in a definite rhythm, and the plum begins to swim. Here and there small animals come its way. Splash! The hole sucks them in. They are drawn into a regular stomach. The inner layer seizes upon them in exactly the same way as our stomach and intestinal wall seize upon a beefsteak or roast turkey, elaborating and digesting it. In the absence of an anal orifice, the undigested remains must be expelled through the mouth; and since the mouth and the anus are identical, it makes no difference whether the opening is in front or in the rear.

From time to time little motile sperm-cells detach themselves from our plum, if it is of the male sex. The female develops large quiescent eggs. Besides, there are plums that carry both sexual elements in their body.

For what I have described as a plum is nothing but the primitive gastræa, the primitive intestine or stomach animal, the original, fundamental and primitive form of all higher animals, a cell-mass combined into a new individual of higher type, and with greater division of labour than in Volvox. In the first place, the cells of this social community have divided into "skin," which protects and moves the whole, and into "stomach," which eats and digests. Secondly, in their sexual life, they have retained what the volvox sphere already possessed: not every cell in the swimming plum generates egg or sperm parts. A special set of cells performs the work of dividing off sperm or eggs for the whole colony; they alone attend to the business of sexual reproduction under the strict maintenance of the rule that in order to give rise to a new individual an egg-cell of one colony must coalesce with a sperm-cell of another colony; this new being then developing from the single fusion-cell to the cell-mass of the gastræa form, according to the fundamental law of biogenesis.

Go to a pond, pick a cluster of the familiar floating plant called duck-meat, take it home, and place it in a basin of water. When it

revives and expands, examine it with merely a weak magnifying glass for tiny attached green or brownish buds or unfolded cups, about a centimetre in size. At first glance they appear to be parasitic plants or mysterious blossoms of the duck-meat itself; but their movements and other vital manifestations gradually reveal that they are animals, which, though usually attached at one end, unmistakably possess all animal properties.

It is the so-called hydra or fresh-water polyp, one of the most instructive animals among the half million known animal species on earth.

Now put a bud under a very high-power microscope. Examine it. Dissect it. What do you see? You see your plum, indeed well-nigh the typical gastræa still, an animal consisting essentially merely of a mouth, a stomach-cavity, stomach-wall and outer skin, as well as a separate department for ova and sperm-cells. Among the cells of the outer layer you already find the beginnings of further division of labour. But that is secondary. The significant thing is that this gastræa no longer swims. It has accustomed itself to a stationary mode of life, attached to some support, as the leaf of a plant. Distinctly connected with this is the fact that instead of a locomotor apparatus for driving it forward and drawing the food into its mouth, it has provided itself with "tentacles," little thread-like processes about the mouth, which catch the food and cram it down its mouth.

Its peculiar power to "nettle," to inflict wounds with the barbed hooks of its fine stinging-cells and then to instil a corrosive fluid into the wounds (a power you must have experienced to your discomfort when you encountered jelly-fish while bathing in the sea) facilitates the catching of food by the tentacles. Since this is the exclusive function of the stinging-cells, it shows additional division of labour. An extremely simple form of hydra, the protohydra, although possessing this poison weapon, seems wholly to lack tentacles, therefore being a still more typical primitive gastræa. One is almost led to believe that the gastræa was attached from the very start, so that the oldest gastræa was the simplest form of hydra. Whether free-swimming gastræa are still in existence is, as has already been said, a question in regard to which specialists differ—and for a laughable reason. In a countless mass of lower marine animals their phylogeny and ontogeny at this point agree to such an extent, in other words, the fundamental law of biogenesis prevails among them

so thoroughly, that an embryo might actually be mistaken for a real animal. What one specialist describes as a true surviving free-swimming gastræa, others regard as merely a larva ontogenetically at the gastræa stage. Nothing could better illustrate the validity of the law than this dispute. What speaks further in favour of an original free-swimming gastræa is the existence of the free volvox spheres and kindred organisms, to which they are so evidently allied, as well as the actual appearance of corresponding swimming stages in the ontogenetic development of so many animals. Moreover, some disarrangements of the embryonic history in the true hydra indicate that a certain special evolution has already taken place.

Here you observe in the simplest form what may have been the course of evolution above the gastræa. Attached stomach-plums, polyps, formed with a wreath of tentacles around their mouths. The hydra lives in fresh water, the bulk of the polyps in the sea. The beautiful vari-coloured sea-anemone belongs here. It is these polyps united into immense colonies that give us our corals. The calcareous frame they secrete makes the brooch and necklace for your wife. In the hot tropical seas the skeletons pile up into great islands, and in the early days of earth's history they formed reefs, which we admire to-day as the high mountains, the Dolomite summits of the Alps, for example.

In the further course of evolution the polyps gave rise to the jelly-fish or medusæ; but the type in its essence is still perceptibly the same. In all instances the body that has developed from the gastræa remains cup-shaped, opening only at the mouth, closed at the opposite end, and lacking, therefore, a real anal orifice.

However, the polyp represents but one type of development from the gastræa. In the same pond in which you look for the hydra you find other animals also still very low and also, in part, still very closely allied to the gastræa; some swimming, some crawling, a host of forms comprised in the one name, worm. While in the polyp the gastræa became attached at one end of its body and terminated at the free end in a mouth equipped with tentacles, in the worm the course of development that the gastræa took was that of consistently building up its own body, as it were, for movement in one and the same direction, whether swimming or creeping.

The body elongates, the mouth, after certain vacillations and hesitations, remains in front; while behind a vent gradually forms, so that the body turns from a cup into a tube. Henceforth the anus

expels the coarse remnants of digestion from the intestine. The more organs added through division of labour in the worms and their descendants, the more distinctly do most of them arrange themselves in pairs along the sides, bilaterally, as it were. The intestine remains the long main axis of the body; but the other organs group themselves to right and left in accordance with the principle that a builder follows in constructing a ship or a wagon, as being the most convenient arrangement for movement in one and the same direction. Observe yourself. Yours is still essentially a bilateral structure—a long extended plum with mouth, stomach, intestine, and anus down the middle, and the other organs grouped in halves on each side, a right and left arm, a right and left leg, a right and left ear for hearing, a right and left eye for seeing, with even the brain divided in halves. We shall speak of this in more detail later. It is the pattern upon which you are formed; for you are directly descended from the bilaterally symmetrical worm. When it developed from the gastræa the worm invented this special arrangement for itself, the thing which gives it its peculiar character and sharply demarcates it from the single gastræa as well as from the other gastræal highway, the polyp.

Now you understand the road that the evolution of love travelled in the animal kingdom, from the one-celled primitive being to the volvoxlike sphere, the primal type of every social community; from volvox, through progressive division of labour, to the gastræ. With the gastræa we reached the true animal. Above it the general tree of descent rises in two directions. The stationary gastræa attached like a plant, like a cup-shaped blossom, becomes the polyp. The tubular gastræa developing bilaterally, crawling or serpentining, becomes the worm, and above the worm evolution mounts through the infinite up to yourself.

In both directions there is material galore for our subject, veritable caricatures of love. Do you know Teniers's delightful old pictures—his Temptation of St. Anthony? Among the saint's temptresses, as at his wits' end he sits poring over his book of devotion, are not so many beautiful naked women as hideous larval broods, monstrosities, half skeleton, half embryo, half hedgehog, half witch.

The red moon of a like witching night rises upon us, too, and the werewolves and enchanted pigs howl and grunt at the crossway. But we possess a magic incantation not to be found in the saint's book. We possess the Darwinian theory, which sees a mighty development

in all those distorted marvels. Finally, the spectres drop to the ground like empty husks, and a radiant woman actually rises up in the chaste nudity of a goddess: Aphrodite, human love, the sweet lotus flower, lifting her blossoms from amid all the monstrosities of the thousand animal love-forms, like a lily from black waters.

Where, O Father, are we roving?
Tell us, Kind One, who are we?
Happy are we, onward moving,
Bliss to all it is to be.

Faust, Part II

§ 3

I must keep you with the polyp and its retinue a few moments longer; and I will instantly dispel a misunderstanding that may have arisen in your mind and led you to fear that the rest of our love-history would be boresome.

The little green fresh-water polyp on its duck-meat leaf below and you, *Homo sapiens,* highest shoot of the genealogical tree of mammals at the top of the vertebrates, your ancestors from the bottom up to the good gastræa are the same. And since the fundamental law of biogenesis holds true of both of you, your individual developments, at least up to a certain point, bear very close resemblance. Male organ and female organ; sperm-cell going to join egg-cell; the fertilized egg breaking up; a mass of cells forming and growing, here into the little polyp, there into you—and also into the worm, the crayfish, the spider, the beetle, the starfish, the oyster, the cuttle-fish, the true fish, the frog, and the bird.

As I have already said, the fundamental law of biogenesis in the course of time becomes less able to avoid all sorts of jumps, changes of association, or interpolations in the embryonic history. All possible extravagances begin even in the way in which, for example, the very gastræa is ontogenetically repeated. We have seen that the simplest way to conceive of the historical process of mouth and stomach formation in the original cell-group, that is, the step from Volvox to gastræa, is the cup-like sinking-in of the eating place into the cell-sphere. Very many animals, especially characteristic ancient animals, still go through this process ontogenetically. But in others it is as if the "memory" of the embryo cells performed very arbitrary leaps, caring only for the result to be attained.

Since you now have a conception of the biogenetic law, the variations will not interest you on their own account, and the question arises: Will not the natural story of love from here on be extremely wearisome, since each bit of it is in principle so nearly the same as every other bit, like the perpetual unwinding of the same thread in a Chinese praying-wheel, the *tshuan,* that happy invention to relieve pious but lazy people from the task of praying, a machine indus-

trializing devotion, as it were. It keeps turning out millions of times the same strip of paper with the original, profoundly excogitated saying, *Om mani padme hum,* "The jewel in the lotus. Amen." So the mill of love whirls, man and woman, egg-cell, sperm-cell, fusion, division, a mass of cells, hum, hum to the end, the *om mani padme hum* of love.

Nature is not so dull as that. Go to the telescope. You see planets large, small, white, red, greenish, yellow-white, Venus, Mars, Neptune, Jupiter, Saturn, all suspended and drawn about the sun by the same law of gravitation yet each a world with a glory of its own. Venus with her white cloud envelope, Mars with his red wastes and greenish stripes of vegetation, the giant Jupiter with his salmon-coloured vapour stripes and bloody spots, Saturn with his awe-inspiring system of rings, an inexhaustible store for study from which mankind will draw for thousands and thousands of years.

Each single animal group, indeed, each animal species, stands before you like a planet, a most wonderful individuality, for all that it is held under control by the same fundamental principle as the others. In fact, just as it is from the differences in form of Jupiter, Saturn, and the earth, existing in spite of the same fundamental force, that you learn to understand the earth and take interest in it, so it is from all the variations of love in the animal kingdom that you begin to see man's love-life in its true light. That there is immense scope for such variations, despite the fundamental similarity of the path all creatures originally followed, is beautifully illustrated by the very example of the polyp.

Take four principles from your human love-life which are incontrovertible.

First, you love in pairs, man and woman, the woman having the ovary, you the spermary.

Second, when you, man and woman, love each other, the resulting product is a child, which, though as yet a "little" man, is doubtless from the day of its birth a human being, not another sort of being.

Third, the child you beget must be in the world many years, it must have reached bodily maturity before it becomes sexually mature and can again reproduce or give birth to children. It never happens that a child still unborn in the mother's womb or a child just born gives birth to new children.

Fourth, you, the human kind, are a state, a social community of milliards of single cells. Your individuality, however distinct, how-

ever true a type of individuality, is after all of the second degree, as it were, taking its origin from the adhesion of milliards of simplest individualities. Be that as it may, as you are now constituted, you are a distinct human individual, or person. It is of persons like yourself that humanity is composed. A number of persons may combine to do many things in common. They may form a club, or a social community, like a nation or state. Human beings have introduced division of labour among themselves. This man cobbles shoes for the others, this man publishes the newspaper, this man manufactures the sausages. The love-tie of two human beings is a union of this sort. Yet it never happens that persons grow together like cells. Even the boldest, the most compact state does not create a Briareus with a hundred heads and a hundred arms. Even the closest community does not lead to a human rat colony, with fifty or more individuals grown together by their tails. Even the most burning love, the love that would fain consume the object of its passion, does not permanently weld the man and woman together into one bisexual animal.

With the luggage of these four principles on your back, you are now to knock at the door of a magic castle. It is crystal-blue, and inhabited by beautiful vari-coloured elves. Some sit like exquisite flower cups on the floor. Others swim like large shining bells through the blue radiance. You are among the polyps and medusæ. Take your four principles now, and use them as a yard-stick, a unit of measurement.

The little green polyp, the fresh-water hydra, at once upsets your first principle. One and the same individual generates both sperm and eggs, sperm in its fore-part near the crown of tentacles, and eggs further behind. Of course here, too, fertilization must be effected through the products of two individuals. You know the law of inbreeding. Nevertheless, the distinction between the polyp and you remains enormous.

To complicate matters still further, the polyp need not multiply by sexual generations alone. You remember the primitive method by which the dwarfs multiplied. New individuals formed by simple budding or "gemmation." A piece of body detached itself and soon grew independently into a new creature without having to mingle with a foreign individual. In the same way young polypites bud off directly from the hydra's body, just as a geranium stock may grow either from a seed or a shoot. In the plant you think it quite nat-

ural that multiplication should take place by the budding off of branches as well as by sexual reproduction.

The phenomenon is characteristic of all organic development, and manifests itself especially in the field of love. Progress proceeds slowly, as if feeling its way and experimenting. The new is not consciously created all at once. It must prove its superiority. For a long time the old persists together with the new, often a remnant of it dragging along for an infinite period as a silent reserve.

Thus the simple, original mode of love by division without the fusion of two germ-cells stubbornly maintained itself long after the appearance of sexual love. And so also, long after the specialization of the many-celled social colonies into love-cells and non-love-cells, that part of the cell-colony which did not take part in sexual love, under certain circumstances, retained the power of producing a whole new colony from itself. While the love-cells founded new colonies in the sexual way alone, some other part of the colony incapable of sexual love gave off shoots ultimately growing into new complete colonies.

You will understand the permanent value of this if you cut a hydra polyp into several pieces. Were the non-love-cells of the colony not possessed of the power to reproduce themselves, life would soon come to a standstill, nutrition and the other functions of division of labour would cease, and all the love-cells would avail nothing, for they would have to starve to death along with the rest. Instead of that, observe how, by virtue of that peculiar restorative power, the cells of each fraction of the cut hydra go diligently to work, and by rapid cell-division and rearrangement make of each piece a complete colony. If, for example, one of the pieces is only a quarter of the whole, it adds the other three-quarters to itself by budding, and in a short while the house is complete, and all the special departments can function again. You may cut a hydra into tiny, barely visible bits, and yet, incredible though it seems, pretty nearly every minute fraction grows again into a complete animal. To so soft and fragile a creature, so exposed to the danger of being torn to pieces, this restorative capacity is, of course, a splendid protection. True, for this protective method to work, the unit structure of the colony must not be too complicated, too compact and rigid a whole. In the higher organisms, where complexity and compactness of structure increase, as we ascend the scale of life, this power would be of no avail, since the momentary disturbance resulting from the cutting

up of the body would lead to absolute destruction and death before the restorative cells could make up the loss. Thus the restorative power declines as the organisms rise on the tree of descent. If your leg is cut off it does not grow again. With the decrease of restorative power the sprouting of shoots, the asexual production of children through budding, finally ceases entirely. That is why you can beget children only by means of the true love act, and why little girls or little boys do not occasionally crop out from your or your wife's back, knee, or foot like heads of salad from a rich hotbed.

Now to your second human principle. From the human womb issues a new human child. That seems perfectly natural.

I told you that from the simple polyp form, the hydra, develop those glorious medusæ or jelly-fish which are found on every seashore. You know them. When the tide has ebbed you see the soft, smooth, glinting disks miserably drying and shrivelling on the white strand. But in the open sea you see them from the ship in the full splendour of life, the rarest forms of the ocean, many coloured, fabulous, slowly, mysteriously gliding in the endless blue, with their elastic bodies of foam, with scarcely a particle of solidity in them, defying the water world which can snap your huge steamer like a reed.

Such is the medusa, the animal above the gastræa. It resembles a swimming bell, the outside of which is one splendid swimming apparatus. It is the rhythmical contraction and expansion of the outside bell that propels the animal through the water. Hanging down from the margin inside are more or less numerous fine, nettle-like stinging tentacles, quite similar to the corresponding structures around the stomach opening of the hydra. And the real stomach is there, too, extending from the centre of the under surface, like a thick clapper, reaching around to the marginal tentacles, and terminating in a mouth that opens downward. Tapering into a long point the mouth may bear extra tentacles in addition to those at the margin. If you detach a little hydra polyp and throw it into the water so that its mouth hangs downward, and at the same time spread out the top into a beautiful swimming-bell, you will have the medusa in all essentials. You can easily imagine that the medusa has "descended" from the hydra. Now consider the development of the medusa, the story of its love and mode of production. Let the jelly-fish, the aurelia, a medusiform common on the New England coast, serve as an example.

Almost all these medusæ are unisexual, each individual being either a sperm-bearing male or an egg-bearing female, in this respect, therefore, resembling man more closely than does the hydra. On the other hand, they differ from man in that their sexual products are in many cases passed out from the mouth. But this is not so very strange, since in the jelly-fish the stomach and the mouth absolutely predominate; they are the principal features of the organism. An anus, an opening at the other end of the body, is still lacking. If an animal simply spits out the waste products of digestion through its mouth, then why should it not reproduce and beget children through the mouth, just as men beget children through the canal through which urine, also a waste product of digestion, is passed. The method is somewhat unusual, though in essence the same as in higher animals. What follows seems to be the ordinary regular course of development. The sperm-cell finds its way to the egg-cell. Do you think the result is a new medusa? Were it to be, I shouldn't have told you the whole story.

From the fertilized egg of the medusa emerges (after somewhat shifted volvox and gastræa repetitions) an attached polyp. Similar in structure to the hydra, it sits contentedly on its bottom like a cup, with a stomach inside, a mouth on top, and tentacles around the mouth, and lives and eats and seems perfectly grown up. It is just as if one day your wife in childbed were to bring into the world, instead of a manikin, a full-fledged salamander or ornithorhynchus. What is to be done? Wait.

Imagine the following: Here is a cup. This cup all of a sudden plays you a crazy trick. Out of its middle grows a new bottom; then between this and the old one still another. Finally, there are, as it were, three cups, one inside the other. And now, bing! the upper one breaks loose, falls down and forms a new cup by itself. The second follows suit immediately afterwards. And since the lowest one also remains, you have now in all three cups where before there was only one.

You would have to go to a magician to see such a miracle performed with real cups. But in the polyp produced by the egg of the jelly-fish you can see nature do it every day.

There sits the polyp, in form really not so very unlike a cup. The hollow of the cup forms the stomach, the opening above the mouth. What next?

Transverse walls grow in its stomach. The animal becomes con-

stricted at the places where the walls form. Instead of one there are now several cups, one inside the other. At first only the top one has a scalloped margin of tentacles. But soon similar tentacles sprout out like a little crown around each of the constricted parts below. Suddenly the top cup with its old mouth and crown of tentacles breaks off and becomes an independent animal, then the next, and so forth.

How strange! The detached little cups do not sink to the bottom, and settle down as new polyps. Turning around with their mouths downward, distending their backs, and swimming freely in the water, they turn into medusæ.

What becomes of your second human principle? A man begets a man, but a medusa begets a polyp, and a polyp a medusa.

But you have learned something, and you are now going to turn your knowledge to account. There is nothing strange in this, you say. It is no more nor less than the working of the fundamental principle of biogenesis. The medusa is historically descended from the polyp. Therefore in its individual development it repeats the polyp, and does not become a true medusa until after it has passed through the polyp form. It is no more peculiar a phenomenon, you think, than for the embryo of man to have gill-clefts like a fish, or a small tail like a monkey. In a way your reasoning is not beside the mark. The medusa is indeed historically descended from the polyp, and no doubt the emergence of the polyp in the medusa's life-history is, on the whole, a reminiscence and repetition in the sense of the fundamental biogenetic law, just as is the appearance of the gill-clefts and tail in the human embryo.

For all that there is something special, something very special, in the case of the medusa. Consider the matter closely.

In a comparison of the individual developments of the medusa and man, the polyp, the very unripe young of the medusa, corresponds somewhat to man's embryo at the fishlike stage. But the "medusa embryo" is a mature creature. It does not pass into the medusa form by changing as it grows, maturing only after it has become a medusa. The human embryo undergoes changes as an embryo, and when it is born it comes out a human being, which matures into an adult. The polyp embryo of the medusa behaves exactly as if it were a full-grown animal; it reproduces itself.

Yes, there is no doubt of it. What else is the division into cups than reproduction? To be sure, it is asexual reproduction.

But we have already seen by the example of the hydra polyp that in this lowly race of animals sexual reproduction is by no means the only, the essential mode of reproduction. Peacefully, side by side with it, runs the simple old process of multiplication by budding without the true love act.

To recapitulate precisely, the polyp-form medusa embryo buds; it gives out from itself a whole pyramid of cups, one on top of the other. Then these cups, which are medusæ, develop organs for the other, the sexual mode of reproduction. The organs produce sperm and eggs and thus start the cycle anew.

You see what a tremendous contrast to you. Your fishlike human embryo simply grows into yourself; and when you have reached a certain age you are sexually mature and able to reproduce. The polyp medusa embryo, on the other hand, has the power to reproduce as such, and instead of growing directly into one medusa it produces by multiplication a whole brood of full-fledged medusæ.

You see, further, how we have unexpectedly invaded the third principle also, and, insofar as our case here is concerned, have unmistakably routed it. The two principles, the second and the third, hold each other at bay, as it were. Either you assume that the medusa becomes quite a different animal, a polyp, which in turn brings forth medusæ; or you regard the polyp developed from the medusa egg as an embryo or larva, as an "unripe medusa." It is just as if your wife were to give birth to a kangaroo or ornithorhynchus, which were then to give birth to a human being. On the first assumption law two falls. On the second assumption law three falls; for then you have an unripe embryo, which becomes ripe as such (a verbal paradox) and brings forth young.

It makes you a little giddy, doesn't it? But you must follow. In Nature's book of love, too, there are passages where the novice feels like our good old friend Sancho, who "continued on his way reassured, for he was now quite satisfied that his master had gone insane." I must adjure you still more strongly. For now comes the fourth principle. Arm yourself against one of the greatest organic wonders on this old earth of wonders.

If, notwithstanding all the popularizations of science, animal life were not a castle bolted and barred still into which only a few initiated occasionally venture, then all the politicians, sociologists, and philosophers would long ago have had to ponder upon the mar-

vellous phenomenon to which I shall now introduce you, and learn a lesson from it. I don't know how many have even heard the bare name of it. I am sure you don't know what it is. If I were to perpetrate a poor joke on you and pretend I was telling you of something in Mars, you would think my story a bit of comic satire, a Baron Munchausen fable ridiculing human social relations, but on the face of it bearing the stamp of the impossible.

The fourth principle states that complete human individuals cannot as such grow together the way single cells originally grew together to form a man's body. Such a result no social tie, not even love, can bring about. The Siamese twins are a monstrosity, not a higher evolution. It is upon the very independence, bodily and spiritual, of the human individual that man's social ideal is based. I see you are eager to go on a sociological excursion. Very well, agreed. We have now arrived at a corner in the great animal arena where there is no escape from the truth of the following story. The case demands all your thinking faculties. Indeed, at first approach it seems to defy them.

. . . . . .

Here is a jelly-fish or medusa swimming in the water. It is a unit individual, in principle exactly like you. Like you it consists of a number of cells united into a close community to give rise to a new, higher person, which is just as much of a distinct, unit individual as yourself. There is a division of labour in the cells; there are specialized organs, not as many as in your body, but yet very distinct. There is a stomach, a swim-bladder, a certain nervous apparatus, and above all a group of organs generating sperm and eggs. In brief, though the medusa is on the whole not as highly developed as you, it is evidently on the same plane from the point of view of individuality. It is Mr. or Mrs. Jelly-fish So and So, just as you are a particular human individual, duly named, identified and, so to speak, officially recognized and registered.

These individual jelly-fish are generally found in the sea in large schools. Why not? They are social in their habits. But though gregarious, each remains an individual for itself. All of a sudden in the beautiful blue and orange row, you notice a creature that seems to be an entirely different sort of animal. With difficulty you succeed in catching it. You examine it. It is a medusa, yet not a medusa. What is it?

Imagine taking a dozen single medusæ and dissecting them organ

by organ. Here the swimming-bell, here the stomach with its mouth, here the peculiar nettling tentacles, here the male or female generative parts. You lay the organs of one kind neatly together in small piles, just as you sort roses and carnations according to their colour. Then you tie them together into a large bouquet, a jelly-fish bouquet, with twelve swimming-bells in one bunch, twelve stomachs and mouths in another, twelve partly male, partly female reproductive sets in a third, and an immense skein of stinging tentacles in the fourth. These jelly-fish are so beautiful and so varied in colour, so like flowers—why should not some exquisitely delicate hand in their own element tie them into bouquets like dahlias or roses, in plucking which you cut off only a particular organ, the blossom.

How wonderful! Is there actually a Böcklin man of the sea living in the depths of the crystal palaces of the ocean, who in his leisure moments makes bouquets of gay medusæ to pin on the corsage of his green-eyed nixy love? And did one of the animal bouquets slip from his hands to be washed to your feet, you student of nature? The peculiar thing you saw in the midst of the swarm of jelly-fish, which seemed to be an individual medusa and which is now lying before you dismembered, is indeed a bouquet, but a bouquet which led an independent "life" of its own, and lived as a whole.

No Böcklin man of the sea artificially compounded it, no knife cut the parts out from a number of medusæ and joined them into one. It came swimming through the water, a complete individual in itself, an organism capable of living and loving. Before you lies what is known as a siphonophoran, a jelly-fish colony.

One thing fundamentally differentiates the siphonophorans from the other jelly-fishes. Ten thousand jelly-fish may be swimming in a row close beside one another, yet each will remain an integral self-sufficient animal, while a siphonophoran is not a single animal, but a bouquet, a colony, a social community, or whatever you will, composed of many animals. It is a cluster of single medusæ woven together like rats united by their tails.

You have heard of this rat phenomenon. A hideous scuffling and squeaking overhead in the barn, worse than the noise rats usually make. It has been going on for some time and you can't stand it any longer. You chop away the rotten beam. A monstrosity comes darting out, the result of abortive growth or disease, twenty odd rats so entangled and knotted together by their tails

that no one of them can free itself from the rest. They must all pass their lives in Siamese propinquity. A zoological tradition, the truth of which is doubted, but it will serve for our simile.

The union of the twenty rats is by no means a monarchy, but a highly impractical republic based on force and coercion, a mere occasional perversion of the free anarchistic life rats usually live. However, conceive that a rat colony of this sort feels perfectly comfortable and gives rise to a specific development. The tails become so completely amalgamated that the blood circulates freely from one to the other through the entire colony. The twenty rats now stand approximately, though even more directly, in the relation to one another that a mother does to her unborn child, which lives in the womb from the blood circulating through her body. The child does not need to do its own eating; the mother's blood feeds it. It does not need to do its own breathing; the mother's blood purifies and renews itself for the child. What if the twenty-rat aggregation, with the same blood streaming through all, were one day to introduce division of labour among its constituent individuals in the same way that division of labour was introduced among the primitive cells?

Henceforth five rats are to do only the eating and digesting, five only the biting when an enemy is near, and five only the running and pulling of the others. Since all the rats get the nutritive blood, the eating done by the five is enough for all. Since all are defended when the five bite, the biting of the five is enough for all. The third five furnish the means of convenient transportation for all. Each group has only one kind of work to do, and can concentrate its energy upon one function.

This logical division of labour would react upon the body of our social rats and produce certain modifications. The five devoting themselves entirely to eating would acquire a more intensely working stomach, but would grow lazy in other respects; their feet would shrivel up and by degrees become altogether paralyzed. The five others that did nothing but snap and bite would develop great courage and increasing energy for biting, but their unused stomachs would shrivel and degenerate. What would the final result be? Some of the rats in the colony would be all stomachs, others sheer biting heads, and others nothing but jumping legs. Such a monster would no longer seem an aggregation of twenty rats but an independent creature, the most preposterous sort of

animal with five biting heads, five stomachs, five times four legs, and so forth. The tail skein in the middle would seem to be the fundamental part of the body of this hideous monstrosity, this collective rat *à la* Cerberus.

Well, there is no such thing in rats. But you actually do find it in our siphonophorans.

A cluster of jelly-fish grow together so intimately that the nutritive juices actually do stream into all of them through a common axis, such as that formed by the hypothetic rat tails. The locomotion at one end draws the whole colony along, and it swims as a single person. Once the individual jelly-fish have grown together division of labour sets in.

Some of the jelly-fish merely eat; some turn their sole attention to moving the swimming-bells; some do nothing but defend the colony; and some devote themselves exclusively to the work of reproduction. Now, since each jelly-fish of the colony makes use of only one of its organs, the natural consequence is that all the other organs gradually deteriorate and at last disappear entirely. The jelly-fish at the head of the colony, which do nothing but expand and contract their swimming-bells so that the whole colony may swim in the blue sea, are in fact nothing but pure swimming-bells without stomachs, without generative cells, without tentacles. Those further down, which resemble open polyp flowers, have become pure polyplike stomach animals; they had played the rôle of "stomach and mouth" only, and thus finally lost their swimming-bells. Others are pure tentacles for defence and for catching food, others pure generative persons with sperm and egg-cells.

You have heard of the many-celled animal. You yourself are one. But here you have a many-animalled animal. In the many-celled animal the cells through division of labour formed into organs. In the many-animalled animal a number of complete many-celled animals reformed themselves into organ-animals, thus constituting as a whole a "superorganism," a true Cerberus or Briareus, bolder than the boldest invention of myth. What more striking rebuttal of your fourth human principle?

Many of these jelly-fish states or siphonophorans are among the most beautiful and most glorious forms in nature. Swimming nosegays, made not of flowers, but of transparent gay crystals, as Haeckel, who knows them best, describes them. Thus, like swimming gardens of ineffable beauty, they stretch across the deep blue

Strait of Messina, upon which nature has lavished her wonders. Thus they present themselves to the seamen in the tropical ocean—the so-called Portuguese men-of-war, their large floats the size of a child's head lying on the mirror of the water like chased silver, glinting violet and purple from the blue of the sky, and crowned with a crest of brilliant carmine; and hanging from the floats, the delicately ultramarine-blue eating, generative and protective jelly-fish.

This whole temple of glittering colours loves. Of course it does. And its love is particularly instructive because it shows the origin, the "individual" development of this monster state, if indeed the use of the word individual is permissible in this connection.

Along with the eating animals, moving animals, protecting animals of the colony, there are also, as already noted, purely reproductive animals, sometimes male and female together in the same colony, sometimes male alone or female alone. As a rule they preserve their outer general jelly-fish form with the bell-shaped mantle and a tap under the bell which looks like the lips of a mouth, but on closer inspection is seen to be grown together. The reproductive animals also obtain their food from the common supply of nutritive juice streaming through the whole colony from its eating members. In return the wall of the tap sets free in great abundance, here female ova, there male sperm-cells. And the swimming-bell, though still preserved separately, serves merely the purpose of enabling the reproductive jelly-fish under certain circumstances to leave the community when it reaches full maturity and sail out independently in the open sea in order to deposit its reproductive freight.

The fundamental fact of reproduction, of course, remains absolutely the same. Sperm and ova-cells of two different "superanimals" must find each other and unite to start the cycle anew. From the product of the fusion of the "state-sperm" and "state-egg" there is born in quite the normal way but one animal, one jelly-fish. From this jelly-fish there then grows up by budding, that is, asexually, the "state" that I have described.

The road that I told you is regularly followed by the individual jelly-fish of another kind, the road from the egg to the polyp, from the polyp to the jelly-fish, seems here to be entirely abandoned. If our interpretation of the facts is correct then the state egg leads directly to the one jelly-fish, and this by budding to the whole jelly-fish stock with its division of labour. But the details are still vari-

ously interpreted even by the best observers. It is enough to know the fundamental fact, about which there is no doubt, that the whole complex siphonophoran is developed from one fertilized siphonophoran egg. All the citizens of the jelly-fish state are children of the same parents, as in the alleged rat-colony, except that all the jelly-fish are not born at once, but first only one jelly-fish, which then produces from itself, like the larval polyps in the cup stories, a number of sister jelly-fish.

It need not surprise you to find a full-fledged child producing from itself a brood of sister jelly-fish. It is merely a repetition on a higher scale of what is a general custom among the lower Volvocineæ, a part of the marvels which this race of animals holds. But your four human principles are checkmated—are they not?—all four of them sung to defeat by one melody, the polyp and the medusa.

But polyp and medusa are only a tiny little star in the animal swarms rising above the gastræa.

Now to the other principle, the worm.

These uncouth monsters, every one,
Had bad clay pots for models.
Against them now the wise men run,
And break their stubborn noddles.

Faust, Part II

§ 4

I shall pick out a monstrosity of the very first order, one that will delight you, I am sure—the tapeworm. Take a good draught to equip yourself for the difficult journey. Arm yourself with one idea, one problem for your fight with the dragon.

Before I describe the love-life of the tapeworm, permit me a short digression into the current theory of the immortality of the soul.

Remember what one of the strongest foundations of that theory is, the column upon which the thoughts and yearnings of mankind through the centuries have propped it again and again. Men would fain see the individual, the soul, the ego saved not only conditionally, by the perpetuation of the species through his children and grandchildren, but also by the perpetuation of his own existence beyond death. His reasoning is very simple. To be sure, he says, we are justified in holding that we continue to live in our children. Some qualities, some parts of our own ego at least live on in our children; certain talents, certain tendencies, both good and bad, all sorts of things that go to the making up of our "selves" live on in them, evidently transmitted in the act of generation. For does not the act mean the real detachment of a part of our body, a sperm-cell or an egg-cell? Why, then, should it not be so? It is also possible, in normal conditions even probable, that our children will again bring forth children to whom a part of our being will be transmitted, and so forth. The chain may continue endlessly, and thus parts and fragments of a particular human individual be preserved endlessly. The answer to the question to what extent are the qualities of the individual preserved depends largely upon the solution of the fundamental problem discussed above, namely, to what extent are our own most individual experiences, our brain experiences, transmitted to the love-cells, that is to say, in how far are acquired characters inherited?

"But," the reflecting mind rejoins, "what a one-sided, what a less than half-way affair this is even in the most favourable circumstances!" To-day a sperm-cell detaches itself, a microscopically

minute particle of my body, about whose portion and legacy I myself know precious little. Now after this act, I, inwardly quite unconcerned about the growth from that cell, continue to be for thirty or forty years or even more a definite ego. I live on, I develop, I get clearer ideas of things, I enrich myself. It is perhaps in these years that I perform my best services for the world and for myself, or do anything at all worth while. And is this whole subsequent "ego" to be totally excluded from immortality?

Let us again take the very marked example of Goethe. With Christiane Vulpius he begot his handsome, unhappy son August, the end of whose short-span life the father lived to see. The son's two stiff uncles in Weimar were the only members of the family that survived. The best thing they ever produced was their wills; they left no heirs. Here the Goethe line of love, in so far as it can be traced, snaps. A very short "endless" chain, indeed. But assume that it continues to this day. Think of the individual Goethe with his giant accomplishments after the year 1789, when August detached himself from him. Does not that period represent by far the most precious part of him? Would it not, in a rationally organized world, be entitled to a different and an especial immortality with greater power and a more certain guarantee of preservation than the succession of generations by propagation?

Once launched upon this question, one usually proceeds to a categorical statement of the case plain and simple. There must be a special immortality, they say, besides the conditional one by way of the love act and children, a special immortality for the parent individual after the reproductive act. That volvox act which brought on individual death cannot possibly be wisdom's final word in answer to our spiritual demands. This might have been so, they say, if the situation were different. It is possible to imagine a state of things in which the idea of a special immortality would not even occur to us. Conceive it to be an iron law of nature that the act of reproduction is invariably the final act of the highest multicellular individual. A man lives, develops, attains full maturity, begets a child, and drops dead; or, better still, is directly metamorphosed into the child. The mother becomes submerged in the birth act as in a fountain of youth. She suddenly vanishes, and in her stead a little child emerges, into whose make-up has passed everything that before constituted the individual mother. Even this would not be a perfect arrangement. Still it would, in

a way, represent a more tangible and positive form of immortality. In a certain conditional sense death, at least for the individual that attaining to reproduction, would resolve itself in a radical process of rejuvenation. The one sperm-cell or the one egg-cell necessary for reproduction would, as it were, swallow up the whole adult parent individual to begin a new existence. It is to be supposed that in so radical an act the transmission of the characters of the father or the mother (we will not go into the question of the union of the sexes here) to the child would be more thorough, since the new individual would consist of all the fundamental capital which went to the making of the previous individual. Death would be like a profound sleep from which one awakens essentially the same as before, but wound up, with fresh energy to start anew. Now suppose that, while the fundamental tendencies and characters are preserved, the immediate personal memories are lost. No great harm. What are our memories? They are characters written on the brain, some of them indistinct from the very first and almost all fading as the years go by. Written notes in books and diaries are far more valuable, certainly in the long run. Is it not possible that a future inventive mankind will be able to photograph the memory, as it were, and thus project it outwardly, so that its entire or essential contents could be handed down even after the disappearance of the brain that had experienced them? And might not the new-born, rejuvenated ego thus be enabled to learn all the old extinct memories again? There are a vast number of other fancies one might indulge in. Very interesting in this hypothetical case would be the assumption that a man and woman coalesced into a third new individual, interesting and at the same time so complicated that one's head begins to turn. But imagine the pretty story being carried to its logical conclusion in the sense of the old myth of the fountain of youth. A whole generation related by blood and stretching for thousands of years into the infinite blue would then appear like one and the same individual, its endless path of life being merely interrupted by moments of profound, rejuvenating, strength-restoring sleep, just as our individual lives are interrupted by sleep at night when our consciousness seems to be interrupted, for apparently the same purpose, the renewal of strength. In the end such immortality through rejuvenescence would render personal immortality superfluous.

But—the dreamer adds soberly, recovering from his reveries—

it is not so. The parent individual in the higher organisms does not wholly merge in the individuality of the child. A very large part remains. There remains that case of Goethe which Volvox seems to have on its conscience. And because it is not so and is not so to be, our optimism is constrained to look for guarantees in other quarters. Here let me gently take leave of immortality and of Goethe, and turn to our dear tapeworm.

You will find the application yourself.

The tapeworm is not *persona grata* to us human beings. It is one of the worst exploiters of our body, and living as it does in the cavernous darkness of the intestinal canal, is the very embodiment of everything unappetizing. Yet, in condemning it, you are like the missionary who held forth to the cannibal against eating human flesh. "It is not only a sin," he said, "but bad taste." "Yes, yes," said the contrite cannibal with a last effort at resistance in his savage conscience. "It may be a sin, but as to its tasting bad, you really know nothing about it." The tapeworm is our deadly enemy, but if you say it is an uninteresting animal, you show you know nothing about it.

From the point of view of objective observation of nature, unconcerned with personal feuds, the tapeworm is one of the most instructive animals on earth, a real natural marvel. It has wriggled its way for ages through the history of philosophy, and has furnished naturalists as well as philosophers inexhaustible material to work upon. Some maintained it was the product of spontaneous generation in the intestinal tract of man. Whenever philosophy, whether materialistic or theological, found spontaneous generation useful, it trotted out the tapeworm; whenever it found spontaneous generation troublesome, it hacked away at it without mercy. In the Middle Ages and long afterwards, it was an established principle of the Orthodox Church that certain lowly organisms were still being produced through spontaneous generation. In proof whereof the Bible was cited. For example, there were the bees found in the carcass of the lion that Samson slew. How did they come there except through spontaneous generation? The naturalist who doubted that this was their origin was looked upon as a heretic. Later, after zoologists ceased to believe that a bee could develop directly from decaying flesh without an egg, some still stubbornly maintained that the tapeworm arose by spontaneous generation, an opinion, as already mentioned, that survived until far into the

nineteenth century. And now the modern theologians were seized with fear and trembling at the idea of an animal developing spontaneously in the living body of man—man who cannot be too far removed from the beast. On the other hand, seeing that the tapeworm originates in so purely natural a way without any special act of creation, the wicked materialists asked why man might not at some time past have developed in a similarly simple, natural way. Thus opinions played puss-in-the-corner with one another through changing periods of history, until special biologic research finally put a stop to the game by proving the whole tapeworm-spontaneous-generation hypothesis to be a mere soap-bubble. In doing so it has succeeded in bringing to light the real love-life of this stranger in the deep grottoes of our noble human system, and has unravelled a chain of riddles such as the boldest philosopher could not have invented.

This love in the living shaft of the human system takes us to a process of generation upon which scientists have bestowed a variety of names, among them, alternation of generations, and metagenesis, but which we, with Steenstrup, will call wet-nurse generation or simply nurse generation. You must not, however, think of a nurse in a clean white dress. Again the zoologist has concocted a name about as bad as can be. Before you get a notion of what it is all about, you must first spin a thread of ideas, as long at least as one of the longest tapeworms of man, say, about thirty-nine feet. But you will find that the trouble you took was worth the while, that there really is something in the name, and it is not so easy to find a good name for it.

Beginning rather simply, the story gets more complicated than the love labyrinths of Ariosto's "Orlando Furioso," which have been called as interminable as tapeworms. Those who made the comparison little knew what an exquisite fairy-tale of love, in Maestro Ludovico's sense, the life-history of the tapeworm actually unfolds.

In the depths of your body, let us assume, a tapeworm is dwelling contentedly. Considered from the tapeworm's standpoint, you have not "missed your vocation" as a human being, but are normal and have it.

You have the choice between the pork tape averaging no more than ten feet, the beef tape reaching a length of twenty-six feet, and the broad tape as much as thirty-nine feet. All three have

their love-history, each with variations. For the moment dismiss every idea of ugliness or disgust. After all there is really nothing repulsive in the intimate life processes of your own body.

Like the sausage that has swallowed itself, you must enter into your own body and look into your own bowels while they are at work digesting. The best way is to follow the method we used before in examining the oviduct, to imagine everything greatly magnified, and to sweep the alimentary duct with a powerful blue electric light.

Open your eyes. You are in a chemical factory on a tremendous scale, running at full blast and astir with intense activity. There are laboratories where substances are changed, broken down, recombined and rearranged; there is a rushing, and roaring and pouring. There are pump-works that suck up precious fluids and convey them to the huge circling stream of other machine systems. The chemicals more or less worked up and ready for use drop down from a large room (the stomach) jerkily, as in an elevator. Instantly machinery in the large factory snatches them up with its retorts and pumps, which separate, transform and conduct them away. A part is eliminated as useless waste, and discharged into the lowest sewer. The rest is strained, distilled and transformed over and over again until the purest extract is obtained. This extract extremely ingenious absorptive contrivances conduct into a sort of general control department in whose widely ramifying system of tubes an exquisite red fluid circulates with a definite rhythmic flow.

This fluid is your blood. By the chemical and mechanical work in the intestinal laboratory the food introduced into your mouth and stomach and there elaborated (as in antechambers) is further distilled and modified into a pure nutritive extract, which is then introduced into the blood. This done, the object for which food is taken has been accomplished, namely, to serve as fuel and energy for an even larger machine system than that represented by the intestine. The most remarkable fact is that all this complicated machinery apparently functions automatically. The factory does not even require light. The retorts work, the pumps absorb, the substances dissolve, break up, purify themselves in absolute darkness. Finally there emerges from this chaos the unadulterated red fluid that is carried throughout the body. How the visitor must thrill with a sense of sublimity when going through these works

through a real laboratory. Here is a factory plant so splendidly organized that it fulfils all our ideals of the automatic machines of the future.

Into this splendid establishment a tapeworm has sneaked.

It does not concern itself in the least with the tremendous machinery in the room or the colossal work the machines are doing to feed a still larger establishment. It is in the position of a small manufacturer who by a masterly stroke of buccaneering has succeeded in attaching his tiny machine to a large motor, whereby he obtains power without having to provide fuel or the expensive outfit for generating it. He has no right to it, of course, but he saw the opportunity and seized it, laughing up his sleeve. Precisely what the tapeworm in your intestine did.

As an animal on a certain plane of evolution, as a "worm," it has its own bodily mechanism. It, too, requires certain nutritive substances to furnish the fuel for its vital energy. By right it should take in its food through a mouth of its own, prepare it with an intestine of its own, and then assimilate it as an extract into its organism to serve as its source of power. But why should it do any work itself? While in the large factory of the human intestine the retorts are boiling, the pumps moving, and the noble nutritive juices flowing from the distillatory apparatus, the tapeworm lies unsuspected in a dark corner of the factory. It has quietly put its belt on the colossal automatic works, and in large draughts simply draws in the pure, refined nutritive juice as if it were a blood reservoir, a necessary part of the large establishment. That shrewd, unbidden guest under the table has solved a great social problem with playful ease, the problem of how industry on a small scale is to hold its own in the face of the giant industry that crushes it.

Ensconced in the innermost sanctuary of a factory belonging to some one else, it can do without certain equipments which are indispensable to others. It needs no door to keep it in communication with the outer world or to take provisions in by. It needs no stomach or intestine of its own. Its nutritive juice comes already prepared, the human stomach and intestine having elaborated it from the raw material taken in as food by the human mouth. Without mouth or stomach, it simply absorbs the human nutritive fluids through its surface. An ideal type of the creature that lives a life of continual feasting without work, it scorns the rule that

he who works not neither shall he eat. In the midst of the most intensive activity it battens in lolling indolence. Dark and hidden as are the inner chambers of the great human plant it often completely escapes notice and remains undiscovered, the managers of the factory in the upper story of the brain merely recording from time to time an unaccountable shortage, the difference between the energy supplied and the actual gain in blood-energy. They give numerical expression to the parasite, as it were, without finding the real stowaway under the table. But the tapeworm, well fed and wallowing in luxury, snug and cozy in his ingenious solution of the social problem, absolutely free from care, proceeds to the business of love-making.

You may be the strictest puritan, the chastest of the chaste; you may be an ascetic who have sworn off love forever, you cannot hinder the frivolous guest in your body from fulfilling the great law of naïve nature. He pays not the slightest attention to your puritan severity, your denaturalized sanctity. Indeed, he fulfills the natural law in the depths of your food-canal with unexampled energy though under rather peculiar circumstances.

You know approximately what a tapeworm looks like. First comes the so-called head provided with suckers (erroneously regarded as eyes), in the pork-tape with hooks as well, for adhering to the lining of the alimentary canal. Following the head is the narrow neck; then the long line of joints or links, which give it the appearance of a worm in the lay sense of the word, and any number of which may be easily separated off and expelled from the body. They are smallest near the head, growing larger the further they are removed from it.

You must now modify this general mnemonic picture to bring it into somewhat closer conformity with the actual zoological facts. What you call the head and neck is really the whole tapeworm, a genuine worm of the so-called class of flatworms, ranking very much lower in the system than even the earthworm and leech, the most familiar representatives of the race of Vermes. If there is a tapeworm head with suckers and neck in your alimentary canal, you have a complete tapeworm individual, even though it lacks all adjuncts. It has no eyes or ears, but a sort of rudimentary brain of the very simplest description, a concentrated nervous apparatus. It feeds upon the nutritive extract of the involuntary

host in whose house it lives, and would be absolutely complete save for its lack of sexual organs.

The contented parasite is neither man nor woman, nor is it a hermaphrodite combining both sexes. And yet—look at it now. It has eaten its fill, and is in a humour to take up its ripest activity. At the place where the apparent neck (in reality the hindmost part of the worm's body) bluntly breaks off, a new, young creature suddenly begins to bud out. It "buds"—we know no better word for it. The young shoot actually comes into being in the same way as a bud in a plant; it simply grows out from the hinder end of the body of the adult animal without any special act of reproduction. It is like a bud, too, in that it does not immediately separate from the parent animal. It remains attached to it, and seems to be merely another joint added to the lower extremity of the worm's head.

The joint does not break off even when a second bud springs from the adult worm and squeezes in between the first offspring and the parent. The two buds which, though divided in "two" by a superficial groove, are not really separated, nestle close behind each other against their parent, like the first links of a chain.

Soon another link is added to the chain. The love energy of the tapeworm, if well fed, is inexhaustible. It gives off one bud after another. Link after link is joined to the chain, until the first tapeworm infant, which has in the meantime grown strong and big, is separated from, or (which is in this case the same) joined to the parent worm by a well-nigh endless series of later-born sister joints. Instead of one worm the chemical factory of your bowels now shelters a whole family, closely joined to each other and constituting that colossal structure which, taken as a whole, is what the layman regards as the real "tapeworm," because to the superficial view it now bears the appearance of a huge worm with a head and rings. But the most interesting fact is this: the young that arose by budding are not in every respect like their parent. They, too, have their nerves and certain rudimentary organs; they absorb nutritive juice, in short, are regular infant tapeworms. In addition, however, they have perfectly developed sexual organs, the male and the female organs in one and the same body. Every worm child produces spermatozoa which can be conveyed into a protrusible copulatory organ. Nearby is an ovary with a vagina behind which are the ova. While the adult tape still diligently con-

tinues his love activity by gemmation, love begins to stir in his budded offspring also, but with this difference: reproduction is here effected not through budding or gemmation but by means of the higher, the sexual form. The tapeworm joints or segments, each constituting both a man and a woman, and closely linked together as they are in the human intestine, cross-fertilize, each supplying the other with sperm for fertilization and with ova to be fertilized Here, too, as in all hermaphroditic organisms self-fertilization seems to be the exception.

Sooner or later after fecundation the eggs surround themselves with firm shells. In the best-known tapes of man the egg-shells do not form until after the eggs have developed into young embryo tapes in the uterus. The number of eggs produced is enormous. The pork tape, which has a crown of hooks on its head in addition to suckers, can, by budding, produce a chain of as many as a thousand joints or bisexual tapeworms, the colossal "broad tape" more than four thousand. Each of these little young tapes again generates about fifty thousand regularly fertilized eggs. A single tape of the most prolific variety, therefore, will yield an offspring of 200,000,000 grandchildren.

With the production of the mature eggs the principal life-work of the second generation of tapes is accomplished. That the whole chain with its thousand or more members should remain permanently in the living human body is impossible. Even though the head with its suckers and hooks clings tenaciously in the bowels, and under certain circumstances abides there for a dozen years or more sucking nourishment and sending off buds, the furthermost links of the chain gradually break away, and disappear through the cloaca that drains off all the waste of the great chemical works. Often when expelled from the system they are closely packed with mature eggs, sometimes they are empty. In the latter case the eggs are sure to get into the cloaca independently.

The young of the tape released from the family chain, washed by the viands of the eternally spread table of the laboratory, suddenly precipitated into a horrible gorge, first inside the factory, and then clear out of it, twitch and quiver for a while in the fearful place into which they have been dumped and then perish miserably, leaving behind them the eggs as the sole evidence of their existence.

The egg endures longer. For the time being it requires no nourishment, and its hard shell can resist the decomposing influences of its

extremely destructive surroundings. But what is to become of it in the end?

To begin with, it shares the fortune of the objects of its environment. The ways fate may choose for them are various. Some lead into the open field, into free, lovely green nature. Some drop into the all-scattering, cleansing arm of the waters and swim about in crystal green seas, or in blue rivers. Some of them pigs eat in the simplicity of their good, sound appetites to which everything is pure. Some, of course, fall on naked rocks and are doomed to die. The first three situations, however, seem to be exactly what the third generation of tapeworms is prepared to cope with, each according to its kind. An ox in the pasture eating grass swallows an egg with the tapeworm embryo inside. A pike gulps down a hearty drink, and the tape embryo that fell into the clear water and swum about freely and in the meantime burst its own egg shell, is installed in the fish's stomach. The good old family sow munches her breakfast, and another tapeworm egg, perhaps still in its dying mother's body, drops into the soft, warm berth of the pig's stomach immediately after its descent into the awful gorge.

In all these places the little embryo seems to be thoroughly at home. If it is still embedded in the egg-shell, as is usually the case with the tapeworm varieties that enter the ox and pig, then the shell is dissolved in the acid juices of the stomach. Thus set free it bores its way into the best of muscles by gripping the stomach wall with its hooks. There it settles down for good, throws off the hooks, and from a microscopically tiny creature grows into a fat bladder as thick as a bean. Gradually it again acquires a very solid shell. At this stage the layman calls it bladder-worm or finn, not knowing that it really is a tapeworm in disguise.

The finn seems to be condemned to inactivity. It cannot by its own efforts depart from the host, nor does it possess genital organs, so that it cannot engage in reproduction. However, it soon begins to exhibit mysterious signs of life.

Just as the first generation of children sprang like plants by budding from the tape of man in the beginning of the life-history of our tapeworm, so there develops inside of the bladder-worm a little head with a little neck which projects like a cone into the interior of the finn vesicle, and which is no less than a tapeworm head such as you saw in your own food-canal. Some tape varieties develop more than one head, indeed hundreds and thousands of

them, either directly, as internal cones of the one vesicle, or by budding off new daughter finns, in each of which a tapeworm head arises. But let us confine ourselves to the simplest case, that of one head in the bladder.

Even so the situation is remarkable enough. The bladder-worm lives in the muscle of a pig or ox cut off from the rest of the world. Conditions in the pike are similar, except that the processes are somewhat simpler. In the finn lies the future tapeworm, firmly imbedded in the interior as an infant bud, but incapable of independent development except in the food-canal of man, where it can again multiply itself. How to reach the food-canal is the question. Bladder-worm and head hope and wait. One day the hour strikes when ox and swine are slaughtered, and hang in the butcher's shop, beautiful, appetizing meaty rounds of beef and ham, bladder-worm and tape-head included. And the hour strikes when the pike goes into the net. Now comes the turn of fate.

Whether you are a poor poet in an attic and feed the fire of your genius with the cheapest grade of liver sausage and onions, or whether you will have none of pork, or whether in pious peace you let the Friday fish glide down your gullet—whatever you do, you eat and are merry, and the tapeworm is in you. The finn of the ox and the pig is swallowed with the meat, and gets into your stomach. The tapeworm has now attained its earthly goal. The stomach juices destroy the hard external shell of the bladder-worm; they digest it as they digest the meat with which it came. But just as the hard-shelled egg withstood all the savage chemical attacks to which it was exposed without the slightest injury to itself, in fact, celebrated the bursting of its shell by the stomach juices of the pig or ox as its emancipation; so the little head now, evidently the essential and most energetic part of the bladder, maintains itself intact. Grasping the new situation, the little thing, until then projecting into the interior of the bladder, turns inside out like the finger of a glove. It buds out from the remnant of the vesicle. Pretty soon that remnant disappears like the shell, and the head alone remains.

It goes from the stomach into the small intestine, not carried as elaborated nourishment for the human system, but entering as a person, in high glee, master of the situation.

You are back at the beginning again. Tapeworm head, new budding at the posterior extremity, fecundation of the sexual tapeworm

segments, fifty million eggs in the poor poet, or, if the blessing comes from the pike, which has a still directer way of delivering the tapeworm head, two hundred millions.

Don't be too frightened by the number. It seems that on the whole the tapeworms do not increase. Practically each produces only one new tapeworm. Even from among two hundred million eggs only one, as a rule, finds its way back again into a man's body; which is not remarkable considering the extremely complicated path it has to travel. Now go over the whole case once more.

The love-history of the tapeworm by way of the finn obviously involves no less than four generations. Real sexual love with sperm, eggs and copulation characterizes the first generation, the highest stage, namely, the tapeworm segments united like the links of a chain in the food-canal of man.

Their normally fertilized eggs grow into a finn or bladder-worm.

The finn buds off the tapeworm head.

The head-tapeworm in its turn buds off the bisexual children which go to the making of the chain of segments.

Reduce this to human terms. In the regular order of things you and your wife beget a boy. At first he looks quite human, but when he gets big you observe that he is strangely different from you and inclined to live quite differently, too. You look at him shaking your head, when, lo and behold! a child sprouts or rather unfolds from his nose. The child is very unlike him, more nearly resembling you, though by no means like you. You follow your grandchild's career with increasing interest. There! A child sprouting from him, too, from his shoulders. This time the child looks so much like you that you might be mistaken for each other. And, surely enough, he follows your habit of life, too. As you did in your day, so does he now; he begins to look for a wife. Instead of pursuing the nose and shoulder method of production he enters upon the old and well-tried path of love that you yourself trod.

Note the resemblance to the story of the medusa. But here the process is still more complicated. To unravel the tangled mass and throw some light upon it, the zoologist had to find a suitable name for it. He saw, as you yourself no doubt would have seen in a similar situation, that the familiar series, father, son, grandchild, great-grandchild, would not suffice. In our simile the order was something like this: father, dissimilar son, nose-child, shoulder-child, similar son. The zoologist affixes to the tapeworm the word

"nurse," and counts: true tapeworm father (the chain of segments in food-canal of man), grand nurse (the finn), nurse (the tapeworm head in food-canal of man), true tapeworm child (the new segment child budded off from the tapeworm-head).

You see this love-story can never be brought to a happy ending in the same generation, with the hero and heroine "getting" each other. To arrive at such a consummation, the romance must be continued through several generations, and absurd as it may seem, before the tapeworm reaches the goal of true sexual love, he must die at least once (as finn) and twice endure a lifelong sexual celibacy (as finn and as head).

Your brain reels. But let me fix your attention upon one more point. Note in this romance it happens twice that the one individual must die in order that the succeeding one may live. The segment of the chain, in many respects doubtless the highest stage in the whole series, since it is the only form endowed with organs of generation and capable of reproducing by copulation, is forced to leave the dear, warm, cozy alimentary tract where manna in the form of already digested nutritive juices flows to it from all sides, must first descend into the cloaca of man, thence be rushed headlong into the terrible decomposing sewer outside the human body, and there be hopelessly exposed to decay, in order that the well-armoured egg may re-enter the road of salvation to the ox and the pig. The bladder-worm in its turn must issue from the ox and the pig, enter the stomach of man, and there perish miserably from the juices of the stomach, in order that the head-tapeworm may reach its destination in the intestinal tract of man.

True, one generation lives on and on despite of and beyond all offspring—the head tapeworm. It continues to sit at the fountain-head for ten years, in extreme cases, it is said, for twenty years, and buds off generation after generation behind it, unconcerned, a patriarch whom death seems to have forgotten. To him apply Busch's words: "He has everything behind him," and he is "praise God, a paragon of virtues." It is only when his host dies that starvation grips him and he, too, succumbs to death. And yet he is a creature of but secondary rank, a "nurse" excluded from the higher type of love between individual and individual.

Now that you have learned what nurse reproduction is I can add a few more love-stories that will still more clearly show the relation between creator and child.

We will linger with the worms.

I cannot unfold the whole system of worms to you. Under any circumstance the task would be extremely difficult. Zoologists themselves are at loggerheads about the classification of the worms, and long ago fat Karl Vogt of Genf declared that perhaps the best thing would be to hang all systems on the wall, and merely agree on Busch's verse:

The worms differ in their length.

We shall therefore confine ourselves to a few essentials. Throw the worms mentally into three heaps.

In one heap put the flatworms, to which the tapeworms belong. This heap stands lowest on the scale of worm evolution. They are probably descended directly from the primitive stomach animal, the gastræa, although some of them, like the tapeworms, subsequently got rid of their hereditary stomachs.

Evolved from the flatworms are the intermediate classes, embracing with all their ramifications an immense assemblage of the most divers forms. As a good transition group you have the ribbon-worms, among which there are giants sixty-five feet long. Then you have—a veritable "mob" of names—the arrow-worms, the round worms, and the acanthocephala, the acorn-worms, and spool-worms, the last perhaps suggesting affinities with the vertebrates, thus with the human tree of descent, which once upon a time must have grown in this forest of worms. Besides these giants you have the tiniest conceivable infusorian-like dwarfs in the microscopic rotifers or wheel-animalcules. A striking collateral branch of these are the sea-mats or moss-animalcules, which build colonies like the corals, the mollusc-like brachiopods or lamp-shells, and the tunicates, living in husks made by themselves, and also related in their origin to the vertebrates.

Of all this wild race, you as a layman, I dare say, know only a few representatives of a single group, the round worms—the trichina which is so fond of man, a worm belonging to the genus *Ascaris,* the pinworm also parasitic in your intestine, and the vinegar-worm which contents itself with your vinegar bottle. These are the worms, properly so called, of the intermediate type.

Now set aside a third heap, and you have the annelids or "ringed worms." They really represent a great step of progress over the average worm type. Impress it on your mind that the true worms

are the ancestors of all the higher animals, the molluscs, snails, cuttle-fishes, starfishes and sea-urchins, crustaceans, spiders and insects, fishes, amphibians, reptiles, birds and mammal, that is, the animal forms closely related to man. All these higher animal groups are historically derived from the worms. Of course there were transition forms, which, though not yet entirely evolved out of the worms, cannot be classed with them. The ringed worms, in the opinion of most naturalists, constitute such a transition stage, forming a bridge between the true worms and the crustaceans and insects. The attempt of some zoologists to connect them also with the ancestors of the vertebrates did not meet with equal success. This last class of worms contains specimens with which you are more familiar than with any other worms, the earthworms and the leeches. You now, therefore, have a picture of at least one or two types of each of the three principal groups of the worm tribe. That will suffice for our purpose.

A warning by the way. There are a number of animals which you call worms, all the fat creatures in decaying meat, in "living" Limburger cheese, in "worm-eaten" apples, which, zoologically speaking, are not worms at all. They are maggots, the early undeveloped forms of insects. If you observe the maggot in the cheese or the meat for some time, you will see it change into a fly, which is a far more complicated and highly organized animal than a true worm. The deceptive worm form of this insect is merely a cry back to the worm by way of the fundamental law of biogenesis, a pale reminiscence of a really wormlike form once the ancestor of this insect.

We will linger on for a moment down at the bottom among the flatworms, of whom there is many a startling love-story still to tell.

§ 5

There is the diplozoon, a little monster infesting the gills of the carp. Imagine two cucumbers, in miniature of course, grown together in the shape of an X. Each tiny cucumber is really a worm by itself. As a matter of fact, each first lives by itself for a while, and in the single state neither shows the slightest trace of reproductive organs. And yet one day it is seized by a strange desire. It unites with another worm, the ventral sucker of each grabbing hold of the dorsal papilla of the other. Henceforth, joined together like the Siamese twins, the two seem to form but a single animal. On coalescing in this way, the double animal grows sexually mature, each part possessing both the male and the female organs. But the law against inbreeding demands reciprocal fertilization, in this case evidently made possible by that prelude in which each seized the other by the collar with a grip so vigorous that they could nevermore let go. Yet, to make matters quite safe the vaginæ of one partner in the artificial Siamese twins grow together with the spermatic ducts of the other. Thus there arises a creature, which, as one complete individual, seems to fertilize itself by its own one reproductive system, while as a matter of fact we have two individuals here meeting each other in the system and cross-fertilizing—a love monstrosity, an erotic Briareus with twofold body and four sets of reproductive organs.

Here is another flatworm closely related to the above, in older terminology well named the gynæcophorus, or the woman-bearer. It forms an exception to the rule in having separate sexes. For safety's sake the female from the very first remains attached to the male. It nestles permanently in a special channel on the ventral side of its male protector, so that the male may be said to be a sort of kangaroo carrying his wife in his pouch like a child. The faithful animal resides by preference in the bladder of the negro in Africa sucking its food like all parasitic worms and causing malignant bleeding known as the Bilharzia disease, from Bilharz, a

German physician in Cairo. The fiend, too, bears the name of Bilharzia.

But that is not really what I wished to tell you about in sequel to the story of the tapeworm.

Transport yourself once more to the marvellous chemical works of a digestive system. This time let it be a sheep's. A particularly important chamber of the factory in the liver. Here is distilled an extremely precious extract, absolutely essential to the running of the plant. At the end of the chamber is a large reservoir, the gall-bladder, in which the extract is kept. A special pipe, the bile-duct, leads from the chamber and the reservoir to the main hall where the digestive apparatus works, the intestine.

Here in this important pipe of the factory dwells the liver-fluke, a flatworm, no less of a plain, out-and-out freebooter and unbidden guest than the intestinal tapeworm itself.

The liver-fluke in its way is more independent than the tapeworm. It has a mouth and intestine of its own. For that very reason, however, it is the more dangerous to the factory into which it has smuggled itself. It drinks not bile but liver blood and thus does direct injury to the walls of the duct. Swarming in large numbers in the same spot, the parasites cause obstructions, inflammations, and debility in the bile apparatus, and finally run the whole factory to the ground. The sheep die of the so-called sheep-rot.

But in the meantime, before the source from which the nutritive juices flow is dried up, the liver-flukes taste the joys not only of the table in the bile-duct, but also of love. Though bisexual, they, like the tape segments, cross-fertilize, and throw masses of eggs (millions) into the large intestine, whence they are passed out with the excreta and reach the outer world intact.

The sheep has now fulfilled its duty in the fluke's love and may go. The rain sweeps the meadow where the waste products were deposited, the liver-fluke eggs are carried into the water, and a jolly little embryo pops out from the egg-shell, a tiny fluke larva, which with the help of a thick coat of fine cilia rotates freely in the stream. It even possesses an eye and can see the light of the world, a gift which the adult fluke could not boast, but which it had no use for in the pitch-dark land of bile. However, its enjoyment of light and freedom is of short enough duration. Soon it loses its coat of vibratile cilia, and with the glorious wandering student hours behind

it, it crawls like a downright worm into the body of one of those pond snails of the genus *Limnæus* whose dainty shells are found everywhere in the mud of fresh-water ponds. You no doubt guess that it becomes a "finn," as in the case of the tapeworm. But it must get back into the body of a sheep, and sheep are not in the habit of eating fresh-water snails. The development of the plot in the fluke story is far more complicated even than in the tape.

Having entered the body of the snail, our worm undergoes strange vicissitudes within its own body. Its parents before it constituted a menace to have taken possession of the finn itself. The stirring activity in its body can surely not be a manifestation of the joys of love. It lacks the necessary organs. In fact, it is to be assumed, they are not joys at all.

Young animals of the form of tubes develop in a most mysterious way from the unfertilized cells. More follow, and more and more. Before long they fill the whole space of the body of the adult worm; its organs disappear, its skin becomes drawn taut as a bladder; the entire mother animal which has hatched this terrible brood dies and turns into a large sausage jacket closed all around and holding within it the new generation of worms in the shape of a close-packed colony of tiny sausages.

The sacrifice of the individual for the perpetuation of the species. You expect the little sausages in due time to burst the skin and pursue their own aims in life. For the tiny tubes inside the skin are themselves not merely envelopes; they seem to be already prepared and equipped to live for themselves as individuals, possessing a mouth and gut like the liver-fluke in the bile-duct of the sheep, and even a special opening, which suggests real love and real laying of eggs. But the little creatures never crawl out of their mother's skin. While still lying there motionless, new life begins to stir in the tiny sausages just come to life. A brood of young arise within themselves in the same mysterious way, without any sexual act, extremely minute liver-flukes with locomotor tails, looking almost like tadpoles. Again these tiny creatures of the third degree push out so that the organs of the mother worm are ruthlessly squeezed away. But when the highest extremity is reached, the procedure takes a somewhat gentler turn. A natural door opens to the tormenting spirits. Liberated from their mother, they puncture an exit also through the grandmother who in the meantime has completely dried-up, and swarm out into the large protecting snail.

Then they leave the snail too and swim into the open water from which their young grandmother once came with her cilia. They travel far, far into overwashed meadows, and having arrived at a favourable spot make a halt and settle upon some grass stem. There they drop their tails; a gland secretes a viscid slime, which dries quickly and forms a capsule round the little monster. The order of the day now is to wait. The capsule protects it as well as the egg-shell once protected its progenitor. Sooner or later, fortune favouring, a sheep comes along and eats the grass and the tiny capsule on the grass; the capsule melts, the liver-fluke crawls from the stomach into the intestine, and from the intestine into the bile-duct. All hail! The original position is regained, the sheep gets the rot, the love-making in the bile-duct starts the cycle anew, and millions of fluke eggs are again sent out on their eventful journey.

This is the love-history of the liver-fluke. Now reduce it briefly to "human" terms.

You marry and have a child. But your child is rather unlike you. At a certain age it is suddenly seized with pain, is, indeed, in quite a critical condition. Without ever having loved, grandchildren grow up inside of him, in formidable numbers. They press the internal parts of his body to the wall until he is no more than a hollow skin flopping around the infernal brood. But the horror of the drama rises as the plot unfolds. Great-grandchildren develop in the grandchildren and in turn push the latter to the wall, so that they open all the doors to rid themselves of the grim devils. Finally the whole fabric bursts open and the great-grandchildren rush forth. They grow into human beings like yourself, and like you marry and taste the sweets of love.

As in the tapeworm, you have the chain: grand-nurse, nurse, true fluke child. Here, too, before one complete stage of love enters as a link in the chain, you have two celibate lives and two victims meeting death under the most horrible circumstances. But the death of the parent individual is not effected by external conditions favourable to the young such as are the decomposing waste substances of the laboratory or the corrosive juices of the stomach. You see the bearer of the children herself squeezed into a sausage jacket, and then stretched taut like a lifeless umbrella by the growing brood of, and in, her own body. Doesn't it seem like pelican of the good old Christian-zoological myth, which wounds its breast and feeds its young with its own life-blood?

Thus far they go, the poor little worms that gnaw at their mother's vitals in the genuine sense of the word.

I said that the middle and largest story of the dear family of worm embraces, in addition to numerous other groups, the so-called round worms or threadworms to which the trichina and the vinegar-eel belong. To complete the picture of the tapeworm, let us spend a brief interval in the company of the vinegar-eel.

When you shake your vinegar bottle before the light, or (if you are an author true to your calling) your paste-pot, and make your tiny little domestic friends, unafraid of either acid or gluten, swing in the turbid medium, you have no idea what a rich set you have fallen in with—rich in that good sense of naïve Nature, who is inexhaustible in her love-stories.

There, close by, is the wheat eel-worm, which, as a larva, possesses the lasting qualities of a mummy. For years it lies in a dry state in grains of wheat, and hopes and survives until the grains are sown into the ground. Then, while the ears of wheat are ripening, the higher love-life of the adult wheat-worm begins its antics.

There is the heterodera, the so-called "threadworm of the beet fatigue." This wonderful word was coined in the sixties of the last century. Beet fatigue was the terror of the farmer; it was like the old cry, "The Huns are coming." This time the spectral enemy came from the earth. Everywhere the sugar-beets began to decay. It was as if the bountiful earth, which had nursed them until then, refused to serve and nourish them any longer. The soil rose in rebellion again the beets. They called it "beet fatigue," and the chemists analyzed, and came to the conclusion that long cultivation of the beet had exhausted the soil and drained it of all its potash. So millions were expended on potash manuring, until finally some one discovered the real exploiter, the secret parasite hidden in the beetroots. It is a worm the theatre of whose love covers that part of the world which extends from the skin of the sugar-beet root to the heart of it, and from the heart back to the skin again.

You, man, are living in the cosmos; your gaze sweeps the farthermost stars, and the whole huge terrestrial ball is beginning to be too small for you. For your mind it became too small long ago; soon you will find it almost too small for a simple wedding trip. But here you have the space of the sugar-beet, and upon a fraction of this space a whole love-story, complicated in the extreme, with the intensest joy on the one hand and the most harrowing tragedy

on the other—life, love and death, all unfolding themselves on a fraction of the space of a beet.

The beet strikes its roots into the soil, a sturdy vigorous plant, when tiny little worms not more than half a millimetre long, with pointed spines toward the end, which are almost suckers, bore their way into its finest root ends. Slowly they crawl up into the juicy substance of the root-meat. Like the child in the fairy tale, eating its way through the mountain of pancakes, the worm traverses the body of the root, and one day finds itself, the Columbus of its planet, close behind the outer wall and boundary of the new world. One last bit of tunnelling and the skin of the beetroot, too, would be bored through, and a gate to the super-beet world opened.

But at this point, at the very confines of this side of the beet and the universe beyond, the wandering creature is overcome with a vague longing; the dream of love seizes it before it has had time to pass into the larger world. Until then there was nothing in its make-up to suggest love. It was neither man nor woman. All signs of generative organs were lacking. Now, all of a sudden, the worm sloughs off its skin, and the simple thing seems to turn into quite a different creature. Nestled hard by the outermost wall of the beet, each worm, each tiny living thread, swells into something like the form of a bottle. Bottle after bottle keeps growing in bulk, the elastic skin of the beetroot bulges out as if the old beet were about to bud off a brood of strange young beets. Part of the bottles continue to swell until each resembles a bulging lemon, which pushes against the skin of the plant until—smash!—it bursts, and the point of the lemon projects outwardly. This forward point is the hind part of the worm. It contains an opening—the female sexual gate. The little lemon animal has turned into a woman, and thus projecting outside with the hind part of its body and the genital aperture, it awaits further developments.

The developments are not long in coming. Not all the wonderful creatures in the beet have become female lemons. A part of them, after having eaten their fill and attained the familiar bottle form, walked out of their bottle envelopes from the lower end like a sausage crawling out of its skin. As thin little threadworms, each of these restless souls, simultaneously with the changing of their coats, have turned into "males" with regular male organs. No sooner are they in possession of the new power, than they seem to have had enough of the old beetroot. The new-fledged gentlemen

pierce through the plant skin, climb on the roof of their prison outside and enamoured in the thraldom of the old mysterious erotic "attraction," look for the eternal feminine. It lies by the wayside. Everywhere the little lemon ladies project to meet them. The opportunity is quickly seized and utilized.

It is but a fleeting moment of ecstasy. "The flower that bears fruit must wither."

Scarcely have the ova been fertilized and begun to mature when the inevitable decline of the internal organs of the lemon female begins. The uterus breaks open and throws the eggs sheer into the mother's body, whereupon her intestines melt away. The tragedy of motherhood proceeds apace. The eggs have not yet become real infants before the entire mother animal is reduced to a brown capsule lying rigid and dead in the skin of the beetroot. One day this capsule drops from the beet entirely like ripe fruit. Then the young worms also break through the skin, swarm forth into the black earth and begin to look for a new beetroot. The male worms, expelled from the nourishing beet where they had their home, have perished long ago. And to cap the climax, in the last act of the tragedy, the beet dies from "beet fatigue." The end of the world.

Another picture in the kaleidoscope. The sphærularia bombi. It has nothing to do with bombs. *Bombus* means "bumble-bee." The bumble-bee-eel, therefore.

Do you know the fairy tale of the bewitched pot of broth which kept boiling and there was no stopping it except by pronouncing a certain incantation over it? But the incantation was forgotten, and so it boiled and boiled until the whole village lay buried under the sweet rice-broth. The terrible story I am going to tell you suggests this fairy tale, but it is even worse, though the beginning is as gentle as a May idyll.

The young bumble-bee-eels dwell in the earth far from the bumble-bee, from good and evil, and rice-broth. There they mature and love. When the eggs have been fertilized and the little female carries them in her body, and the manikin is dead, then begins the maddest Jules Verne adventure in the whole world of worms.

The woman with her eggs sneaks treacherously into the female bumble-bee hibernating in the earth, and settles in the body cavity

of Madame Bumble-bee. You think she will lay her eggs there, and sphærularia bombi herself seems to think so. After she has comfortably set herself up in her new residence she begins calmly to turn her vagina out of her genital aperture with the good object, no doubt, of despatching her living freight to the outside as fast as possible—But what is this?

You expect the young brood to issue from its receptacle and leave the mother in peace. Instead of that the vagina hanging out from the aperture seems itself to become a thing of life.

It stretches, grows, swells, and puffs up out of the aperture like an unloosed balloon, pulling away with its uterus and ovary. The broth-pot in the fairy tale! Now the horrid thing is as long as the entire body of the tortured mother, now it is longer, now twice as long, three times, ten times. At the same time it grows correspondingly in thickness; the difference in bulk mounts to as much as fiftyfold, a hundredfold, a thousandfold. A gigantic pouch of monstrous dimensions—and still it grows and grows. Like the village under the broth, so the mother's body dwindles into a mere insignificant appendage. Soon it is 15,000 times as large, and the end is not yet. At last the ratio is more than 20,000 to 1. The vagina itself has become 60,000 times as large as its original size.

Reduce this to human terms, and imagine the stretching to be in only one direction. You then have a falling of the womb which hangs out a distance of one yard, ten yards, 100 yards, half a mile, until finally, taking the height of the woman to be five feet, it covers a stretch of eighteen miles from the possessor of the womb; that is, farther than the distance from New York to Sandy Hook. You may remember Jean Paul's story of a man whose nose was so long that it had a start of a mile, and arrived at the city gate two hours ahead and was arrested because it had no passport.

The mother dwindles and dwindles and dwindles, collapsing under the horror of the monstrous phenomenon. Now she is a microscopically minute, useless tail; now she is singed away entirely by her own frenzied organ. The colossal vagina falls like a ripe pea pod into the bumble-bee, filled to bursting with a fresh, jolly brood of young sphærulariæ bombi.

But this, too, is merely by the way. The really important story, and the reason why I introduced you to the society of the threadworms, is that of the genus eels which the zooligist calls "rhabditis,"

(*rhabdos,* Greek for "rod"), more specifically, the dark-veined rhabditis (*nigrovenosa*).

Rhabditis male and rhabditis female, distinctly separate in their sexes, emerge in the damp muddy earth, extremely tiny little creatures, the man about two hundredths of an inch long, the woman almost twice as long. They quickly find each other and quickly love, as independent citizens of the damp soft earth, quite adverse to parasitism.

The rhabditis is provided with means for quite a respectable act of copulation. The larger female has her genital opening in or near the middle of the body, the little manikin carries his at the posterior extremity where it is united with the intestinal outlet. But not only is the male genital aperture pressed upon the female; there are besides other special and very effective instruments for copulation. As a rule, the male has at his intestinal exit a pair of strong gripping spicules, which generally lie in a special pocket and are thrust forward only for that purpose. Sometimes, too, the entire extremity of the body widens into a small bell which holds the female in a sucking embrace.

Scarcely is the honeymoon of our rod-eels over, when signs and wonders of the most critical nature begin to manifest themselves in the body of the love-satiated female. Like all creatures of her kind, Madame Rhabditis has in her body cavity a uterus, which after impregnation contains fertilized eggs. Soon the eggs become children, the minutest little rhabdites, which could very well leave the mother body and roam about freely in the large habitat of muddy earth. But they do nothing of the kind. There are not many of them, at the utmost four, often not more than one. They remain in the uterus, stretching themselves, rolling up—crash!—the uterine wall breaks, and now a very painful situation arises.

Painful, that is, for the mother. The little worm pelicans begin to devour her viscera, in the literal sense of the word, never desisting until they have *eaten up* completely, and only her skin remains hanging, an empty dead wrapper about her murderous children.

A while longer and the maternal skin, too, is burst open, and the rhabditis brood crawls out into the mud. Still sexless, they pass from the earth into the lungs of a frog. Parasitic animals, strangely metamorphosed, the worms dwell here for a considerable time and develop, each for itself, both sexual organs in the same body, in marked contrast to their parents whose sexes were distinct.

Their offspring emigrate through the intestine of the frog back to the damp muddy earth, and become rhabdites of the original type with separate sexes.

"Heterogeny" is the name scientists have given this extremely curious transformation, the one generation which consists of man and woman of distinct sexes, the next generation of hermaphrodites with both sexual organs in the same body, and the third generation returns to the original unisexual form.

There is a special reason perhaps why this case of the rhabditis should impress itself strongly on your mind. Should pious souls, with all too great zeal, but none too great regard to the actual state of things, urge upon you that nature as it is to-day is built upon love, that is a providential goodness pervading it; should they preach that the tiniest little worm appreciates the love of that which has created it—then summon the vision of that poor little mother rhabditis writhing in the damp earth, a cannibal feast for her own children.

I intimated before that I, too, at the bottom of my heart believe that "love," in quite a definite sense, might lead us again to the heart of the world; that some day this word, even in its realistic meaning, might become our profoundest symbol, the symbol of the overcoming of all painful separations and the fear of individual isolation, the symbol of smiling death which is not really death but an evolution. To-day such love is a divination rather than a solid possession, yet it may come true as a very reality. This new birth from the germinating soul will be infinitely superior to the old ghosts, still as numerous among us as the sands which are upon the seashore. The faith that nature was from the beginning based upon the refinements of the highest form of human love and universal human compassion, and that it is governed according to this plan, is but one of those ghosts. A single martyr, like the rhabditis, and the faith falls to the ground. The philosophy of the tiniest worm upsets all the nice subtleties of the philosophy of man.

§ 6

Many a chapter more might be written about the love of the worms. Right next to the rhabditis you find the threadworm syngamus. *Syn* in Greek means "together," and *gamos* "marriage." The syngamus is a creature which takes marriage in desperate earnest. It also offers a fine illustration of the truth that there is no place where life is impossible. Let a hair get into your throat, deep down and uncomfortable, so that you are seized with a fit of coughing and fairly choke. In this so instructive situation imagine that the hair has turned into a living worm, and that the worm has chosen your windpipe for its residence, dining-room, love chamber, and all. A number of birds, woodpeckers, magpies, pheasants, ducks, and others have the enviable good fortune of being inhabited by the syngamus in this most appropriate of all places in the world. Suspended from the large air passage of the windpipe, like tiny fiery red sausages from a mantel, they sometimes succeed in so stopping up the tube that the bird chokes. Whether it be that, owing to the draught created by the incoming and outgoing air, the lovers are particularly liable to the danger of separation, or whether it be because of the extreme ardour of their passion, the fact is that the adult syngamus is always found double; the genital aperture of the male at the extremity of his body being all his life firmly attached by suction to the genital aperture of the female at about the middle of her body. This animal may, with scarcely any exaggeration, be said to live in perpetual copulation. It would seem that from here to the growing together of the sexes is but a step, and thus we should have a male and a female sexually distinct turning again into a hermaphrodite. If this were to happen the law of cross-breeding would at one stroke put a stop to direct copulation, tilting the scale to the opposite extreme, as it were. It would then become necessary for the hermaphrodite to seek out another hermaphrodite. Make a mental note of this ridiculous case. It will claim our attention again.

Place beside the syngamus the green bonellia, in every respect one of the most remarkable worms in existence. It practises a mar-

riage form, the like of which it would be difficult to find anywhere else in nature.

Among the Battaks of Sumatra there is a funny legend, of a wicked man who absolutely set his mind on seducing the wife of a friend, who was a good husband. In vain. He could find no door to her heart. So he hit upon a trick. He turned himself into a sweet apple. The woman, in pregnancy, seeing the apple on a tree, conceived a longing for it, broke it off and ate it. The villain triumphed in her stomach. "Ha ha! I got what I was after." The Battak, it seems, does not make any very nice distinctions between the heart and the stomach in his anatomy. The story so well suits the love-history of the bonellia that you might think it was a creation myth specially invented for the strange animal.

The bonellia in its usual form resembles a small dark-green pickled cucumber, less than half an inch in length, with a sort of extensible stalk or bud growing out from the anterior end over the mouth considerably longer than the cucumber itself and forked like the tendril of a vine. It lies among stones in the mud of the Adriatic Sea. The repulsive creature with its cucumber body and long proboscis is the female. To find the male is a much more difficult problem than to find the cat in the newspaper picture puzzle.

You know that song about the "big wife" who went dancing and her little husband who said he wanted to go dancing, too. This situation is nothing compared to the matrimonial relations which obtain in the Bonellia family. Mrs. Bonellia with her proboscis extended is about one and one-fifth inches long. Next to her stands Mr. Bonellia in his full military length of, at the utmost, eight hundredths of an inch. The proportions, then (taking the smaller Bonellia males), is that between a man and a flea. For such a diminutive manikin, if it wants "to go dancing, too," the safest way is to jump into the fold of the "big wife's" skirt. And actually, in the Bonellia family, to find the male, you must look for him in the interior of the female.

Affording, as it does, a large asylum, the green female generally collects under her sheltering roof not one Lilliputian alone, but several. As many as eighteen males have been found in the body of the female bonellia. At first, when the manikins are still young or inexperienced, the wide mouth of their spouse seems to them the best gate to enter by. They attach themselves firmly in the food-canal (pretty nearly like the Battak lover in the story), and there

absorb nourishment and lead a snug comfortable parasitic existence. After they have had enough to eat, they begin to feel the stirrings of love, to which they are fully entitled, since their extremely stunted bodies are equipped with an enormous sperm sac. The food-canal now no longer seems to them an appropriate dwelling place. They crawl out again from the mouth of their future mistress, descend a short distance on the surface of the green cucumber, until they discover a better door, namely, the aperture of the female generative organs.

With the discrepancies in the relative sizes which here prevail, the manikins find this door also sufficiently ample. Of course, no act of copulation in the ordinary sense can take place, the opening itself being wider than the manikin at any part of his body. Fertilization must therefore be brought about in another way.

Like Baron Munchausen boldly sailing with his whole ship into the belly of the whale, so the Lilliputians march into the body of the female bonellia in all their length and breadth, pathfinders conscious of their purpose. Once swallowed up in the abyss they remain there the rest of their lives. They settle firmly in the interior of the female generative organs at the very spot to which the ovary descends, and to which the mature eggs waiting for fertilization are conveyed. However tiny they are, more like spermatozoa than complete male persons, they are now secure, just in the right place for attending to the business of fertilization in perfect security and peace. The green female arches her giant body protectingly round the whole act, and shelters the males and her eggs from the rigours of the sea until every egg has received its requisite mite of fatherhood. Subsequently the fertilized eggs find their way out to freedom. But the tiny Tannhausers remain in the Mountain of Lady Venus to the end of their days.

For many years zoologists have been carrying on a controversy over the question, in which cage of the large menagerie of worms to place the bonellia. Formerly it was generally classed with the so-called priapulus, a worm owing its ominous name (male generative organ) to its rather curious form. The two worms were constituted into a group called gephyrea, which means "bridge worms." The bridge was supposed to lead from the worms to the sea-cucumbers. This proved to be erroneous. Then the group was included under the ringed worms, but this classification, too, had to be given up as

untenable. To-day it is believed that the bonellia alone is a ringed worm, though a very degenerate and retrograde type. Thus we have at last reached the highest group of worms, the third heap mentioned above.

Here the earthworm and the leech are at home, noble creatures compared to the dreary welter below from which we have just ascended. They are both especially familiar to us, because of the part they played in the progress of civilization. The leech holds its own in the history of medicine. The earthworm is the quiet kneader and plougher of the soil continually bringing lumps of earth from below upwards, until in the course of time the entire surface of the realm in which he works is buried in the depths and a new surface created. For thousands of years he has been the archæologist's silent assistant. Through his agency mosaic floorings, stumps of columns, coins and ornaments have been worked down into the earth and preserved for posterity.

The love-life of both is very much alike and comparatively simple.

They are true types of hermaphrodites. But they, too, are hard-bound by the law which runs through the organic world forbidding self-fertilization.

On a cool damp night, when no enemy is stirring abroad and there is no light to frighten the tapering head, which though lacking eyes, is yet peculiarly sensitive to light, two earthworms crawl out from the black soil. They sidle up to each other in such a way that the fore ends lie in opposite directions. You cannot observe any differences in the structures of their bodies, which consist of the familiar, flesh-red rings or segments; for what you see is not a male and a female; each worm is both. If the enamoured pair were to become transparent, you would see that in the tenth and eleventh segments, the head and the mouth being reckoned as the first segment, there is a pair of testes in each, opening by large sperm ducts to the exterior in the fifteenth segment. In the tenth segment, where one of the two pairs of testes lies, and also in the ninth, there is in each a pair of seminal reservoirs, ready to receive male semen from the outside and in due time to conduct it to the oviducts situated somewhat farther behind, where it can fertilize the female eggs escaping from the ovary.

Each hermaphrodite worm, then, seeks so to dispose the critical region of his body from the ninth to the fifteenth segments with reference to the body of his consort, that the bulging opening of his

sperm ducts should press against the empty seminal reservoir of the other, and the sperm-duct opening of the other against his seminal reservoir. In the excitement of the moment the cutaneous glands of the segments involved begin to secrete a fluid that dries instantaneously, forming a sort of common bathing suit for the genital organs of both during copulation, and uniting the pair by so firm an outward tie that for the time being they actually seem to be grown together. Under the protective shelter of this bandage the seminal fluid of each dissolves and flows into the seminal reservoir of the other. Immediately after copulation the solid bandage slips off. Freed from his own semen, each worm now carries a reservoir of foreign semen, and the danger of self-fertilization being removed he may now fertilize his own eggs at need.

The love act of the leech follows very much the same course, except that, naturally, it takes place in the water. The leech pair, when copulating in spring, apply their bodies to each other so that the heads and tails of both lie in the same direction. There are no seminal reservoirs, and the semen is introduced directly into the female vagina by a copulating organ.

If, from analogy with the higher unisexual animals, you imagine both the sexual organs of the hermaphrodite endowed with strong sensations, then it cannot be denied that the leech must experience at the same time the double sexual sensation, that of the giver and that of the receiver.

One is reminded of the Roman Emperor Heliogabulus, who, in his madness, offered a prize to any one who would bestow womanhood upon him, so that he might enjoy the sensations of a woman as well as a man. There is no doubt, however, that unisexuality, a property which this crowned fool possessed in common with all the higher vertebrate animals, was one of the primary conditions of higher and more ideal development, and a reversal to bisexualism could but react injuriously upon the human type. Hermaphroditism is a stage of love that lies behind us and must perforce lie behind us. Look at our art, in which, it is to be hoped, we will learn more and more to see reflected as in a bright mirror the real history of nature and humankind. Look at Greek art. See how even the Greeks still plagued themselves with the endeavour to fashion hermaphrodites in marble, to shape an ideal form combining both man and woman. In vain. It was a task no longer possible, and the result was a monstrosity. In the leech, hermaphroditism is still

a true progressive force of nature; in man, in the time of Phidias, a hopeless patchwork.

All the roots and all the fruits of man's power rest upon the distinction between man and woman, upon that type of division of labour which, even in the most perfect organism, physically transcends the individual.

If you want to indulge in thoughts of the future relative to this subject, you must take the road through the spirit. Already, perhaps, the feeble red of dawn rises before our mental vision. We divine that unisexuality, after it has completed its work in the evolution of man, may some day, somehow, disappear and give rise once more to the fusion of the sexes. But if so, it will not be a relapse into a former state. It will be a process that has passed through the alembic of the spirit. A change of this nature can be effected only in the upper story of the soul. If thence it goes back to the body, the result will be something new indeed, a complete transformation. And in a spiritually advanced future, who knows what the significance of the body will be, or, in fact, of any of our present conceptions? Perhaps, they will be nothing but mere empty husks of the past, husks which evolution has cast aside, just as it has had to cast aside the worm in order to ascend to man.

But I meant to detain you a bit longer with the nurse form of reproduction and things more or less kindred to it, so that you might taste this interesting principle to the full and fathom it in all its philosophic depths.

§ 7

In the life-history of the rhabditis mother we happily reached that point at which reproduction involved not only the sacrifice of the mother individual, but the entire consumption of her by the young offspring, as the yellow food-yolk in the egg is gradually swallowed by the chick. Her internal organs seem to be stored-up provisions for the first meals of the young, and her skin serves for a while as their outer protective shelter.

It is easy to imagine this process extended in the same direction, in a somewhat intensified form, with the result that the offspring finally grows into the mother's skin permanently, as if it were its own, or appropriated one or other of the mother's organs for its own body. It is easy to imagine it, that is, if we were to conceive of the absurdest contingency possible to think of in this connection.

Picture to yourself a human female. A child is growing within her body, and while still there develops teeth and begins to eat her. But it does not devour her completely. It leaves, let us say, her hands and face, and appropriates them so that they simply grow into it and become its own.

You know the story—sacred if told of St. Anthony of Padua, profane if of Baron Munchausen—about the bear and the donkey. While the rider is sitting on his donkey or his horse, a bear comes up and eats the beast from behind until the poor animal is all inside of him, and the bear suddenly finds himself harnessed with bridle and saddle and the Saint or the Baron astride of him. Applied to our case the donkey is the mother, the bear the young offspring, and the saddle the mother's nose, except that we must make the nose grow into the child—which is so preposterous an idea that even legend did not dare to invent it for the most pampered of her children. Nevertheless, I am going to introduce you to an animal in which something strikingly similar takes place.

To do this we must leave the kingdom of the worms.

Go over once more the framework of the higher genealogical tree of animals. From the simple stomach animal, the gastræa, are descended, on the one hand, the polyps and the medusæ, on

the other hand, the worms. The worms are divided into three main groups, the flatworms (for example, the tapeworm), the intermediate worms (for example, threadworms, like the trichina), and the ringed worms (earthworm).

Upon these worms as a basis stand the four highest branches of the animal kingdom: the molluscs (snails, etc.), the arthropods (lobsters, insects, etc.), the vertebrates (to which you yourself belong, and the fishes, birds, reptiles, etc.), and the so-called chinoderms (types of which are the sea-urchin and the starfish). All four of these large branches are descended from the worms, but not successively one after another or one from the other, but collaterally. The starfish never became a snail, the snail never became a lobster, the lobster never a fish. Each of these great divisions is the result of the evolution of the worm in a special direction. One day it came to be that there were upon the earth alongside each other starfishes, snails, lobsters and the lowliest insects and fishes. Each then continued its own development without ever coming together again. From the group which, superficially speaking, begins with the snail, the highest product of evolution is the so-called cuttle-fish. From the most primitive insect the line of descent has risen, let us say, roughly, as far as the ant. The fish in the course of millions of years became man. The sea-urchin and the starfish develop least of all. The sea-urchin itself may be said to be the highest point reached in that line of evolution. This relation—four higher divergent lines in all, though of unequal length, resting upon the common basis of the worms—you must constantly keep in mind in the ensuing pages in order to avoid confusion.

Now that we have done with the worms I have a whole Decameron of starfish, snail, lobster, insect, and vertebrate love stories to tell you from the kingdom of the four higher branches. You must clearly bear in mind that henceforth we shall, in the main, deal with only four principal large novels, the chapters of each of which are often closely connected, but no novel has anything to do with the other.

We shall begin with the starfish line since, as I have intimated above, this line leads into the domain of intensified wonders.

Take a sea-urchin such as you see in the aquarium or may pick up on the sea-shore. At once you perceive why this animal group bears the title of thorny-skinned or echinoderm. In appearance

like a spiny fruit, it is a lump of hard shell covered with sharp points. The only way you can tell that it is not really a chestnut burr, washed ashore by the waves, but an animal, is that it moves.

On looking more closely you discover, even in the commonest sea-urchins, that there is a sort of door to the interior at each of the two poles of the ball. The upper, the north pole, is the outlet of the anal opening, the lower, the inlet or the mouth. Between the anus and the mouth the shell holds, head downward, a fairly well-developed animal, in many respects more highly developed than the worm.

The best thing is for you to regard the animal in relation to the worm. Think of a worm squeezed together until it forms a ball with the anus above and the mouth below. Then imagine its soft skin transformed into a hard armour through inlays of calcareous plates and, for further protection, covered with mobile spines. You can spare yourself the other zoological details. They are complicated enough, corresponding, as they do, with the general remarkable structure of the animal.

The echinoderm has its love-history, too, and a very curious love-history it is indeed.

The Italian fisherman in the Mediterranean looks for a certain kind of sea-urchin from which he selects some and rejects others. Those he retains he can use. He breaks their shells and picks out from the inside five grape-like, golden-yellow objects, which he reckons among the dainty tidbits of his table. The yellow objects are the ovaries. The sea-urchins he selects are all females. The rejected ones had no grape-like ovaries, they were males. So you see, after so many different kinds of hermaphroditism, we are again in the province of strictly separate sexes.

When the full moon scatters its silvery aroma upon the dreamy sea, the female urchin ejects her ripe eggs into the water, and the male immediately pours his semen over them. No real copulation therefore takes place. This simplest form of sexual love, which is possible only in the liquid element, is very prevalent in the middle story of the animal kingdom, and is the rule even among fishes, as we already know from the herring. In the open sea, sperm-cell and egg-cell meet to lay the foundation of a new echinoderm. But how many, and how strange are the vicissitudes that the creature encounters before emerging a full-fledged sea-urchin.

From the union of the sperm and the egg a tiny, transparent little

individual arises, absolutely complete in its structure, but resembling anything under the sun rather than an echinoderm of the family sea-urchin. The little soft jelly-like body possesses a mouth, gut and anus, and swims about blithely in the open sea by means of lively motile cilia. From its structure we should regard it as a young developing worm, and if it were to grow sexually mature and produce young, it would simply have to be classed with certain worms. But it never becomes sexually mature.

By sending off strange points and processes inlaid with fine calcareous rods like the rods of an umbrella, it develops into something resembling a skull-cap turned upside down. One day this skull-cap buds inside. A new animal, totally different in structure, forms in the hollow space between the body wall and the stomach.

The skull-cap is, so to speak, but a "temporary" individual from which the real animal develops later by a process which suggests budding.

The budding grandchild, it soon becomes apparent, is really a little sea-urchin. The snuff-box-like sea-urchin grows in the interior of the living skull-cap in such a way that it includes its stomach. It simply takes it over to itself and makes it its own organ. The skull-cap, separated from its nutritive organ by the ingrowing guest, naturally decays, dies, and finally drops away from the young urchin, dried up like a withered blossom. Baron Munchausen's bear sticking in the saddle. The sea-urchin, having accomplished the internal halving of its "mother," and in happy possession of the mother's stomach which continued to function uninterruptedly, little cares about the vanishing ghost. It eats, grows, completes itself, and finally becomes sexually mature, like its grandparents.

I am not going to involve you in the complicated zoological controversy as to whether this fabulous process is a true form of "nurse reproduction," as in the tapeworm (with the skull-cap as "nurse"), or whether it deserves another name. As yet the views on this subject have by no means been cleared up. The final decision depends upon how one conceives the sea-urchin to have evolved from a worm-like type. The contemplative naturalist, who seeks to ascertain the history of the animal world, the relation between the various animal groups of the tree of descent, finds this intricate life-history instructive in several points. It reminds him once more of that important principle of organic evolution, the fundamental law of biogenesis, which prescribes that the animal in its individual

development as embryo or larva quickly pass through, more or less distinctly, the whole series of ancestral forms. Man in the mother's body once more becomes a fish-like being with fins and gill-clefts. The frog as tadpole becomes fish and salamander. Thus, it seems, the young sea-urchin must once more become a worm-larva as evidence of the fact that its ancestors were worms. Interesting and remarkable as this fact is in itself, you may well imagine that the complete logical solution of it is a hard nut for the zoologists to crack, and success is still far off. What we are chiefly interested in is the purely external aspect of the subject. It opens up to us new vistas in the labyrinth of the concept "individual." Here is this sea-urchin story in which, at its climax, the young not merely eats up its mother, or nurse, or superlarva, or whatever you choose to call it, but takes away one of her organs outright and assimilates it into its own system. Is it not enough to stir philosophers to profound reflection concerning individuality in general?

Our considerations of the many tapeworms, liver-flukes, thread-worms, and, lastly, sea-urchin, have now naturally brought us back to what I told you of immortality.

You have observed a sufficient number of cases in which one individual is consumed in its entirety to make room for the next. Finally you reached the sea-urchin in which one individual gives up its stomach so that the other may live. You ask, How does this concern man for whom alone the ideas of immortality have been conceived? Do not forget that man is an animal, that as a vertebrate animal he is descended from the worms, and that the process of nurse reproduction was apparently a stage in the history of his evolution, though now it lies far behind him.

At what point in evolution, I ask, did the individual become so important that he merited an immortality greater than the simple transformation into his children? Is it not obvious from the foregoing tangible examples that we must learn to regard the whole problem of individuality as infinitely more complex than is commonly supposed?

The trouble is that we are operating philosophically with a concept which in natural history is involved in a whole rat colony of different problems. It is all very well for you to preach that the individual is immortal. But what if, as you penetrate further into the animal and the vegetable kingdoms, the individual itself slips through your fingers—slips, mind you, not in death, but in life?

Parents divide into children, children grow into parents, parents and children intermingle until one takes possession of an organ of the other, such as the stomach. Everywhere there is flux, everywhere transition from life to life, and out of the whole finally emerges man, still an animal in every fibre of his being, a very definite kind of animal, a cell complex, reproducing himself sexually with sperm-cells and egg-cells, a vertebrate, a mammal. It will not do to create a special device for him. The ideas we excogitate about him must correspond to all the facts of life at the bottom.

You hesitate. You have never before used these facts in relation to immortality. Now understand me well. I do not wish to destroy what is dear to you, what you think is essential to your life. I merely desire to give you the facts; you can draw your own conclusions at your own discretion. On one point, however, you must be clear. You must, in your speculations, take into account the results of natural science. You cannot pass them by as the Pharisee did the wounded man in the desert. You must distinctly bear in mind that the whole conventional substructure of your ideas concerning the world, individuality, eternity, immortality, life, death, the ego, mother, child, etc., has been handed down from times that had not yet the faintest conception of the results of modern science.

Upon this sorry substructure, it is true, thinkers have built an edifice of wonderfully profound, grand speculations; and the magnificence of the thought has been such that we have again and again been led to forget the bad foundation. In the meantime scientific research has been steadily and quietly at work building a new foundation at the bottom, until finally the new basic structure has actually been reared. We must insist that this be at least respected.

There are many who believe that the moment we grant natural science this right there will be an end to all thought, all philosophy, all great free flights of fancy. That is the height of folly. The material that science gives us is absolutely free. All you have to do is to accept it. What use you make of it is your own affair. As before, you may venture upon the boldest speculations concerning individuality. I wish you good luck. But you must build them upon and with the new material. To use the same example once more, though it is but one of innumerable cases, take into account nurse generation as found in the tapeworm. Thus equipped, go forth in search of results as you please. Then you will be master

of the situation. In this wise research becomes your sure and certain planet to protect and carry you. Otherwise it remains the lodestone constantly threatening to pull away the nails from your philosophical ships.

Most men to-day still regard biological research as a clog which gets into their thought and which they are unable to control. Everything goes crashing, tumbling and whizzing. And yet this is the very contribution that our time has to offer as its own; and an immense contribution it is. Upon it your thought will blossom forth rejuvenated. It will help you to results as bold as ever you may wish to dream. It will help you in other problems, and it will help you also in the problem of individuality. The great complex which scientific research imparts to this question will perhaps lead to its ideal mastery.

In the meanwhile, to give you at once a good example of the complexity of the problem of individuality, here is another echinoderm story.

True, it is a love-story only in a conditional sense, for, although concerned with multiplication, it is more a matter of divorce, of so highly refined a form of divorce that no author has as yet made it the subject of a modern novel. It is a form of divorce in which one being, he or she, divorces himself from himself.

Sometimes I think such a divorce from self would be a desirable thing for many of our extreme individualists.

These all too consistent individualists lock themselves up away from their fellow men, and look on marriage as an abomination because, forsooth, it might infringe on their individual liberty. There is a great thought in such a striving when manifesting itself in a pure form. But who is strong enough to live up to it? To be alone seems to be a new baptism of fire. But presently the disturber of the peace settles in one's inmost self, and your consistent individualist is seen going out upon a quest with a vague longing in his breast —"Who will free me from myself!"

In vain. In the spiritual sense you may be as much of an echinoderm as you please. As a last resort you may succeed in divorcing yourself from yourself by suicide, but being a man you cannot possibly do it by self-division. For that you must be an echinoderm in the zoological sense.

You remember the single-celled primitive animals who multiply themselves by simply breaking up in two or more pieces. For the problem of individuality on which we have dwelt so much this is a matter sufficiently complicated in itself. However, it may be said that in these lowliest of creatures the concept individual is still so vacillating and the nature of the psychic stirrings attendant upon this self-division so unknown, that it is not safe to base too many conclusions upon them. But observe the following case.

Nearest of kin to the sea-urchin is the starfish.

The starfish is also an echinoderm, though without the round prickly shell of the sea-urchin. In the sea-urchin I asked you to imagine a fat worm squeezed into a lump. Here I shall ask you to conceive a worm pulled apart so that it looks as if it produced from itself five young worms united at the centre and making a regular worm-star. This picture is the more permissible as naturalists used to hold the theory that the starfish arose from the union of five separate worms. This hypothesis, however, has now been abandoned.

The starfish in its adult, sexually ripe state is unmistakably a well-developed "individual," absolutely one in all its life manifestations. Its early development is similar to that of the sea-urchin. Like the sea-urchin it pilfers its stomach from its mother's living body, and removes the useless remnant of the body from its head as one throws off a night-cap. But thereafter it remains "one" in the strictest meaning of the word, and all in all is simply an individual just as you are an individual.

Although the starfish as found on the beach is generally as rigid as an orange peel, one need but observe it for a short time in the water to ascertain that it exhibits very well developed psychic animal life. A complicated nervous apparatus with a large nerve ring which gives off radial nerves along the arms shows it to be a strictly psychic unity. In contrast to most of the other echinoderms it has on the tip of each arm a distinct eye in the form of a refractive red spot. Far from being a passive inhabitant in the "stillness of the sea," it leads an extremely predatory, voracious existence, and attacks and eats little crustaceans, oysters and fishes of the purple deep to its heart's content. Then there is something found in other types of starfishes which perhaps more strongly than anything else confirms the impression that the starfish is a well-defined individual both psychically and physically.

The adult female starfish, itself a product of the reckless destruction of her antecedent nurse form, unmistakably shows certain motherly feelings towards her offspring. Hidden among stones, you see her sitting like a hen with her arms curved over her fertilized eggs and hatched young. A strange picture, yet constituting one of the first rungs in that huge ladder which culminates high above in the human spiritualized relation of the Child at the breast of the Madonna. Some starfishes and other echinoderms have a special pouch in which the parent animal carries about her brood like a kangaroo her litter of marsupials.

Now, then, this "true individual," notwithstanding its extremely complex organization, manages at times to break apart into two individuals just as one of those primitive animals does which has no organs whatever. Amid the wildest convulsions a sort of inner cleavage seems to go through the whole body of the star. One part of the arm wants to break loose from the other. This it can effect only through the splitting of the middle piece. There is a general smash-up; nerve chords and vessels tear, hard skeletal parts break, the stomach splits open and divides in two halves. It literally happens as in the song:

"One half a Turk drops to the right,
And one drops to the left."

Each half lives. If the star has five arms, one-half keeps three and the other two. An eight-armed star is halved in four and four, a six-armed one in three and three. A little later the terrible cleft in the wound becomes glued together and then heals by simply regrowing the parts lacking in each of the two halves. The missing arms on each side also gradually bud out so that sooner or later both individuals are again "whole."

There are now two individuals instead of the original one. Try to enter into the individual soul of this incipient starfish before division, and go through the process mentally. What are we to suppose the animal "thinks" while it is undergoing the process? How long does it think as "it," as "one," and at what point do two souls constitute its thinking ego? Is the division a "death" in which the individual "dies," or is it a step to a larger life, a regeneration of the one individual into a higher form?

Perhaps you will use the leisure of a summer vacation on the

coast of Maine, where the tide every day washes up to your feet large and small, red and yellow stars from the blue watery sky of the Atlantic, to reflect upon these questions. Be assured, no matter what your conclusions may be, they will lead you further than many volumes of speculative philosophy and theology.

§ 8

What mystery new, 'mid the crowds that are wheeling,
Is now to our vision its wonders revealing?
What flames round the shell at the feet of the Queen?—
Now flaring in force, and now shining serene,
As if by the pulses of love it were fed.

Faust, Part II

In school you learned all sorts of nice things. If I should nudge you in your sleep and say, "*Panis, piscis,*" you would go on, "*Crinis, finis.*" Even as an old man, should you happen to have eaten too much lobster salad, you would recite in your troubled dreams irregular Greek verbs, or sentences with conditions contrary to fact, get stuck and receive a zero. These are the things on which, hugging your grey school bench, you spent the best years of your life, your youth, which looms up in your imagination as a blossoming young flower garden. It is the humanistic legacy upon which you were afterwards to build the ideal part of your world philosophy.

Should I ask you, however, not when you are asleep, but wide awake, "What is the oyster on your table?" you would be at a loss for an answer. You would probably console yourself with the thought that the oyster cannot possibly have anything to do with your world philosophy. Money must be made to pay for it, and then it is eaten with or without lemon—eating oysters with lemon is barbarous taste. That is the way the old Roman revellers at Horace's table did, and they as little knew what kind of a creature the oyster was. They did know, though, the conditional sentences contrary to fact, and they handed them down to us, and now they form an absolutely essential part of our humanistic education. However, that is a question which permits of wide difference of opinion.

But the oyster is really too lovely a subject to dispute over, and far be it from us to make it a bone of contention.

To me there is a lot of romance in every oyster. It recalls quiet moments in my life which I should not like my memory to be with-

out, moments in which simple pleasure passed into spiritual rapture. I see lovely girls' heads rising before me—and all sorts of things. Surely of all the culinary delights oysters are among the most ideal, "gustatory flashes of summer lightning," as Huxley calls them. Few foods can compare with them, and those few are all alike in being "unadulterated," since they require no dressing or preparation, like truffles, for example. The oyster has race, a quality which, beside itself, only wine can boast of. And it has perspective. Just as the fragrance of truffles entices you far out into the root-spun eglantine mystery of the enchanted forest to the grave of Merlin, who sleeps under the flaming green oaks thousands of years old, so the oyster takes you in spirit far out from inland to the sea with its briny breath and foam, deep, deep down into the black-green fairy world of the eternal ocean which rises in white crests and over which the sea-gulls flit like snowflakes.

And the spirit flits with the sea-gulls from one fairy tale to another, to that day when all men will sit over oysters and old Rhine wine, united and reconciled, at last really feeling at home upon this rich earth flowing with oysters and grapes—if only humanity would but help itself, if all would but come to a mutual understanding.

As in the shell are echoed forth
The dreamings of the sea,
So in my soul the yearning dreams
Of days that are to be.

The oyster is an animal. That much you know, do you not? To be sure, it is a very peaceful animal. You can eat it alive and it won't stir. Sunk in vegetable sleep, as it seems, you can scarcely believe that it is really an animal. At any rate, you presume it must be a very low type of animal. Think how a worm would turn if you dug it up from its place of concealment and served it up alive on a platter in the bright electric light of a metropolitan restaurant. And yet this motionless martyr is a more highly organized animal than a simple worm.

With the oyster you enter the second of the four higher stories of animal life above the worm.

You are among the molluscs.

There are two groups of molluscs which you meet with at every step in your life, though as a rule you jumble them together into one.

Our language has two words in common use which mark them off quite correctly the one from the other, but the layman does not know how to apply these properly and regards them as synonymous.

One of these words is mussel, the other snail.

Roughly speaking, a mussel may be defined as a mollusc lying between two shells like a slice of red ham between two white pieces of bread in a sandwich. The precious oyster in its plain jacket is a mussel, and so is the salt-water mussel with its dark or purplish shell and its yellow byssus threads by which it is found attached to rocks. On the other hand, the snail is either quite naked like the large red, black, or whitish-green slug, or it has a single, generally spiral shell from which it can crawl in or out at will, like the edible or Roman snail.

The snail is in every respect a more highly developed mollusc than the mussel. It possesses a distinct head usually furnished with movable feelers and eyes, and it has representatives not only in the water, which breathe with gills as do all the mussels without exception, but there are also land snails which breathe air through lungs just as men do.

The historical relation of the two groups is probably this. The original snails sprang from some worm type or other, and then divided into two branches, one giving rise to our present snails, the other, by adaptation to a sedentary mode of existence and by the degeneration undoubtedly connected with such a mode of existence, to the mussels. So in eating the beautiful Roman snail you assimilate the crown and ornament of the mollusc tribe, while in swallowing the formless lump of the oyster body you get the slow, dogged, and somewhat degenerate provincial and Philistine of the same tribe.

This contrast is clearly reflected in the love-life of the two groups, the snail and the mussel.

Whatever poetry may lie hidden in the oyster chamber and in its quiet joys, you cannot, with the best of will, tell a stirring story of love about it.

Most mussels have separate sexes, but no copulatory organs, and so have to resort to a very primitive device, which is possible only in fluid water. Males and females, stationed close to each other in their shells, generate sperm and eggs, and when the proper time comes discharge them into the water.

In many cases the female, after discharging her eggs, keeps hold of them loosely in her body, for example, by simply swallowing them

in her respiratory apparatus, the so-called gills, as in a weir. The male, however, freely discharges his freight on the outside and fills the water with semen in front of the opened shell of the female. She draws a deep breath of it, that is, takes a large gulp of water into her gills and the thing is done. Sperm and eggs meet.

Later the young swarm out from the mother's respiratory pouch. They swarm—for, though already possessed of a small shell, the young mussels do not in all cases display an immediate desire for a settled life. The marine mussels, especially, with their bivalve shells, swim and swarm about for some time in the open sea and look for a suitable place to settle before they finally yield to the increasing weight of their natural house and take up their permanent abode. The young of most of the fresh-water mussels, when liberated from the gills of the mother, fix themselves to some fish or other, which carry them about on trips through the water, often for months at a time.

The love-history of the oyster in the main follows the same simple course. But in that its best-known forms are hermaphrodites the oyster forms an exception to the bivalves. In the same body, nay, even in the same organ, it produces eggs as well as sperm. Nevertheless, fertilization takes place in exactly the same way as described above. For in the oyster's case, too, Nature strictly enforces her law against self-fertilization.

While one and the same organ in the body of one and the same oyster generates both sperm and eggs it does not generate them at the same time. One day eggs develop and escape, swimming along the mother's body into the respiratory apparatus; the mother swallows water impregnated with semen from a helpful neighbour, and fertilization is effected in the regular way by the crossing of distinct individuals. The next day the oyster mother will become a father and produce only sperm. At the neighbour's, on the other hand, it will be "mother's day" when only eggs are produced. To her the sperm-cells are a welcome swallow. She needs them to fertilize the eggs that have lodged in her gills.

The mass of eggs each oyster can produce by thus co-operating in love is fairly incredible. A single adult oyster with sufficient experience in love matters can yield more than a million eggs. Of course, only a very small percentage reach full development.

Nevertheless, there is no doubt that by rational oyster culture devoted particularly to the young broods which swarm out from the

mother's body, oysters could be increased to such an extent at all our sea-coasts that they might become the cheapest food for the people far inland. It is said that a man is disinclined to study on a full stomach. Socially speaking, this is sheer nonsense. As a matter of fact, it is only on a rationally fed, satisfied stomach that a man can even begin to study. Is it not possible that humanity's education would be better promoted if more attention were paid to the oyster than to the irregular Greek verbs and sentences with conditions contrary to fact?

§ 9

Imagine a dainty little picture in Watteau colours. Upon gold-green vine leaves two common large snails with their thick brown indistinctly striped houses wobbling towards each other from opposite sides. They meet and raise their heads. Suddenly the grey bodies turn into rosy angels, little roguish *amoretti* with long buttoned horns cocked on their heads like a fool's cap and bells, as if for the fun of it. The two roguish creatures draw out dainty bows from under their protective roofs, aim at each other and hurl tiny silver darts, love-darts, which unfailingly hit the heart, although they do not inflict real bloody wounds.

Puff!—the witchery has vanished, and again all you see are two adult well-fed apple-snails. And yet you have witnessed something with the eyes of poetry about which natural history has a tale to tell in her own way.

Matter-of-fact science actually speaks of "love-darts," love-darts that the snails use in their amours. Only as always science tells the story after the manner of Aristophanes rather than that of Petrarch.

To the layman a snail's general structure is more intelligible than an oyster's. In comparison with the apparently irregular mass of pulp composing the oyster's body, which looks as if it had been chewed up and spat out, the snail is well proportioned. You recognize where the head and the extremity of the body is, where the back and the belly. It has no legs, to be sure, and on the head, instead of distinct eyes and ears, are those remarkable protrusible tentacles which only ignorant children call "ears." The larger pair of tentacles really bears an eye at each end, though a rather poorly developed one.

Hard by the right eye feeler opens up a little cavity, which, situated in the queerest place, so near the head, is no other than the sexual gate. In examining a living snail for this gate, you must take care not to confound it with the large respiratory cavity of the lung, located farther back.

It would not be easy to find another animal in which next to so simple an aperture there is so complex and elaborate an apparatus.

Every garden-snail, like the oyster, is a hermaphrodite. Deep within the body it has a so-called hermaphrodite gland in which both elements, male sperm and female eggs, are produced in the strangest mixture. From this factory an extremely complicated canal system leads to the outer love gate through which its own mature eggs and enterprising spermatozoa can be conducted downward, and foreign spermatozoa for fertilizing the eggs conveyed upward. For, of course, according to the old law, no sperm must fertilize an egg of the same parent, although both grew in the same hermaphrodite gland like apples on the same tree. The duct proceeding from the hermaphrodite gland is common to both the sperm and eggs, but when they meet here, the spermatozoa are not yet mature, so that no fertilization can take place. Nevertheless, for greater safety, the common duct splits into two portions further down, a narrower male shaft to the left, and a parallel female tunnel to the right: the one for the descent of the rams, that is, the sperm-cells, the other for the descent of the sheep, the egg-cells, and eventually for the ascent of the sperm visitors from another snail. The narrower duct after a short course downward leads into a noble reservoir, which is no other than a large copulatory organ usually retracted deep into the parent body. It opens into the common sexual gate together with the wide termination of the female duct on the right. The reservoir, being protrusible, has the power to extend and turn up so that it stretches from the large genital opening like a long telescope, and is like a real male organ even in outward appearance. As such it can expel the spermatozoa collected in its own body into the body of another snail.

Descending into the reservoir while it is still introverted, the spermatozoa remain there for a while to attend to their toilet, so to speak. By a concretion of slime they are compacted into a mass or packet, known as the spermatophore. The spermatophore has a special purpose of its own, which we shall learn presently.

These elaborate arrangements by no means exhaust the genital apparatus of the snail. It has two other complicated secondary machines. First, there is an empty kettle communicating by a separate duct with the large sexual opening, and further above still more closely connected with the egg shaft. It receives nothing from the inside, neither eggs nor sperm. It seems to have been made to receive something through the sexual gate from the outside. We shall soon see what it is.

Then near the sexual aperture is still another object, which seems to be the most remarkable of all. It is a sac opening to the gate, a quiver-like case, containing a small loose calcareous thing of the form of a little pointed sabre or dart. The perplexing object bears no direct relation whatever to the eggs and sperm. It, too, apparently must wait for something to come from the outside.

Let us now leave the interior of the snail where we have discovered all those signs and wonders, and observe the animal from the outside. The male sexual products are stirring in its body as they mature, but it can do nothing by itself. To be sure, judging by the structure of its genital apparatus, self-fertilization would be an easy matter. The movable, protrusible copulatory organ, armed with its mature spermatophore, needs but to turn in and up the large shaft containing the eggs and discharge the cartridge into the mature eggs.

But our snail will stoop to no such perverse conduct, which is contrary to nature's commandment against self-fertilization. It is a great stickler for "morality." To be sure, its good behaviour is based not so much upon the categorical imperative as upon motives of pleasure. It hopes for something more stirring and transporting, which self-fertilization, it seems, can never give it. This something soon makes its appearance in the form of another snail.

There it comes along, in the sultry June day, with the solemn, ponderous gait characteristic of snails. Built like its partner (the words bride and bridegroom are inapplicable here) it is fired by the same desires. It is clear we are no longer among lowly animals. We see distinctly the manifestation of a more complicated emotional or spiritual element than that exhibited in the lower creatures.

The two snails at once make for each other in evident excitement. At first they circle round in a very funny kind of snail dance. Then they suddenly rear themselves up against each other as high as they can, the "foot" of one snail pressing against the "foot" of the other, while they support themselves on their shells behind. For a while they lose themselves, quite in the manner of human beings, in the bliss of a passionate kiss which they impress on each other with their thick lips. Their tentacles move briskly, their breath goes thick and fast. Instantly their passion rises to such a height that it would seem impossible to stop it.

Contrary to expectation, however, a pause ensues. The excitement does not disappear, but is brought to a temporary halt. Instead of the snails proceeding at once to the fulfilment of the highest

purpose, as is the good old custom of nature, a full half hour or so intervenes in which something special seems to be preparing. At the end of the interval the strangest conceivable intermezzo is enacted. Wildly rearing up again, twitching and bending convulsively, one snail approaches the other with the sexual opening, which, from the queer construction of the snail's body, produces a situation such as you would have in man if one of the lovers were, with the fiercest impetuousity, to thrust the right side of his neck against the neck of the other. Now it is but one snail that so jostles the other, now they both do it. Strangely enough it seems to be immaterial which one of the lovers approaches the other. Nor does the reversible copulatory telescope, behind which the spermatozoa lurk awaiting their exit, appear in the wide-open gate to the right, as you would expect. On the contrary, it is the opening of the egg shaft that seems to be considerably thrust forward. Do these wonderful creatures mean to exchange their eggs instead of their sperm? Do they want to deposit their eggs on the outside of each other's bodies before fertilization has taken place?

Oh, no. With the mouth of the egg shaft in which no eggs are now to be seen, comes creeping to light that puzzling appendage, which I designated before as the quiver of an arrow-like object, a tiny but sharply pointed dart of carbonate of lime. This quiver is distinctly visible, and the mysterious dart it holds is now the leading character upon which the whole attention of the enamoured snails is centred. It is squeezed and pressed forward with endless exertions and motions, as if they were taking aim. It may be two hours before they succeed in getting it exactly the way they want it. Then a sudden thrust, and the quiver is completely unfolded. Now follows the maddest phenomenon.

The quiver discharges itself from within.

Until then only a case for an arrow, it now becomes an automatic fire-arm. A little white cloud bursts out like the cloud of smoke from a detonating pistol, a spray of foamy white fluid. The erotic cannon seems to be shooting water. Yet, with it, it is actually discharging a real shot into the other snail.

Can it be that we are mistaken, after all? Is the thing that we see flying into the other snail the spermatophore that has been so carefully prepared? Was the shot aimed at the egg-shaft opening of the other snail, so that this is the moment of real copulation at last? No. The thing we see flying and hitting the other is the pointed

object in the quiver, the hard little dart itself. Whether it hits the love-gate or not seems to make no difference whatever. It must hit the other snail's body somewhere, that is all. In most cases it pierces the skin of the upraised foot. The force of the muscular propulsion of the quiver that discharged it is great enough to drive it in good and hard. Evidently this dart-shooting is a mighty serious business in the snail's love. Horrible as it is that any shooting at all should have to be done in the midst of the love act, it is nevertheless done with real shot. The snail that is hit distinctly shrinks with pain. Often the sharp dart pierces its body full length; and sometimes when it pierces the lung or the wall of the body cavity, the shooting may result in fatal injuries, though such cases are rare and accidental.

For all this impious tempting of fate, the consequence is immediate success in love. In spite of its pain, and excited though the snail was before, the shooting raises its passion to a climax.

The discharge seems utterly to exhaust it, and it sinks down as in complete weariness. When both the partners give fire at the same time (which is the rule among some types of snails, while in others it is usually alternating) both require a pause of rest. If only one shoots off its dart, the wounded snail, scarce out of its convulsive pain, is seized with the extreme love passion, and barely leaves the other time to recover its breath. This blazing fire it is which now victoriously sets free the crowning act, the sexual union.

How does the dart product this effect? To what extent can the shot have been an excitant to copulation? That it is an erotic excitant has been clearly recognized even by the older observers of the reproductive act in the snails, and all a modern zoologist can do is to confirm their observation. Accordingly the dart has been given the name "love-dart" or "Cupid's dart," in a strictly technical sense.

In normal instances it is gradually forced out of the wound like a splinter, and drops to the ground worthless. By the secretion of lime in the quiver, it may be renewed within a few days for subsequent use. Queerly enough, the structure of the love-dart varies greatly in detail in the different kinds of snails and so affords the investigator a good means of systematic classification. Johannes Meisenheimer of the Zoological Institute of Marburg University, the latest excellent investigator of the love romance of the apple-snails, has not only re-examined the subject with the most painstaking minuteness, but has also taken a whole series of fine photo-

graphs of the love-dart shooting as well as all the other stages of this highly dramatic incident. However, the dart story still does not seem to me to be quite made out.

We are to suppose that an act inflicting positive pain and in certain circumstances dangerously wounding the animal is a refined excitant to the highest emotional love. Formerly it was thought that the love-dart was discharged with the object of hitting the love-gate. According to this view, the dart would be a direct means for tickling the organ, which, though an extremely complicated method, is conceivable, as we know that similar cases occur in the animal kingdom. But recent investigation shows that this is not so. It is true that pain and sexual pleasure are in some way related. It is a familiar fact that there are abnormal, diseased excesses in the sex life of man, in which one sensation induces the other, and the highest erotic emotion is contingent only upon the sting of bodily pain. The horrible perversions of sadism, which transforms the sunny land of true love into a cruel, bloody torture-chamber, have their origin in this abnormality. Are we to suppose that something of the same nature has become the rule among the good garden-snails? To fire their passion must they first fire a load of shot?

I confess I am skeptical of this explanation despite the carnival excesses and death-dances which the lower animals are known to indulge in in connection with their love. I sometimes think that the love-dart may be a stimulation of a finer type, exciting love not through pain but by subcutaneously injecting into the blood a substance acting as an aphrodisiac, an excitant to love. That there are such stimulants is a well-known fact. All love potions from of old are based more or less on this property. Alcohol is one of the surest blood seducers among men. It has untold amorous catastrophes on its conscience. It is another familiar fact that certain snakes have the power of inoculating poison. They use a perforated tooth as a syringe which they insert in the flesh of other animals, and through the hollow of which they inject a poison secreted by a gland in their body. In this case inoculation results, and is meant to result, in death. There is one animal, however, which, biologists conjecture, uses its hollow injection spine for the purpose of conveying a sexually stimulating fluid, that is, an aphrodisiac. It is that remarkable Australian animal, the ornithorhynchus, which as a mammal, though a very low type, is closely related to the ancestors of man at a certain point in the genealogical tree. The male possesses a hollow

spur on the hind foot that receives the duct of a gland secreting a caustic fluid poisonous to other small mammals. But the spur does not seem to be a weapon for poisoning. A more plausible conjecture is that the male uses it as an instrument for a subcutaneous injection into the female before copulation in order to excite her sexually. Unfortunately this strange matter concerning the enamoured ornithorhynchus has not yet been satisfactoaily elucidated. But it is worthy of notice that the love-dart of the snail when discharged, although not perforated, brings with it a cloud of a white secretion. The glands at the quiver of the dart-shooting animal which produce this secretion represent an extremely large organ, and it would certainly be strange if its sole function were to provide a few drops of oil to lubricate the quiver and the dart. Assuming that the secretion is an aphrodisiac, a small amount of which is capable of setting the snail's blood in violent agitation, the desired effect might be produced by the introduction of the moistened dart. It cannot be denied that our observations so far have yielded no direct evidence in support of this vague assumption, and the matter still remains in the dark. There is no doubt, however, that the shooting of the dart possesses the power of sexually stimulating the snail.

As stated above, the success is immediately shown in the love stages that follow. With an impetuosity no longer to be restrained the snails again begin to kiss, and their feet again to beat with a mighty pulsation, now tightening upon each other with an almost crushing pressure, now releasing each other. Suddenly the reproductive organs of the two lovers unfold themselves, not the female organs alone, but most conspicuously the large tubes containing the male sperm. They unfold like a real telescope, first half, then a second narrower slide, until the whole organ extends as one continuous tube. Contact with any object will now cause the discharge of the tube's cartridge of sperm. It is essential therefore for each of the snails to lay its tube precisely in the egg duct of its consort. Accordingly the openings of the oviducts are now gaping like coarse-lipped mouths, ready to receive them. But for this purpose the genital apertures with their male telescopes and female tubes must be properly opposed to each other. Finally after many failures their arduous efforts are crowned with success, and the little necks with their sexual openings placed crosswise against each other. From each side the telescope bores its way deeper and deeper into the female shaft. Not before both the organs are in perfect union, that

is, not before the two snails perform, simultaneously and thoroughly, their function of sowing males and of reaping females, is complete tranquillity restored, and the full serene height of the drama attained. The violent agitation that preceded it, with its growing stages of excitement, leaves no room for doubt that emotionally, too, the absolute climax has been reached, although the wild external movements have given way to almost complete rigidity. The act of copulation at this final stage lasts from four to seven minutes.

If you could look into the interior of the two lovers, who now seem as if lost in a dream, you would see how the male telescope has pushed itself tight into the female shaft. Swollen from the congestion of blood, it cannot immediately withdraw. Strangely enough, after penetrating the egg shaft it changed its direction, turning into the side-track instead of ascending further up the shaft. The side-track leads to the reservoir above-mentioned, which until then was empty, and the purpose of which we therefore did not know. The sperm cartridge is now happily emptied near the aperture of the reservoir, and pushing further by its own motion, finally enters the receptacle. The telescope, having accomplished its work, may now withdraw.

In the receptacle the cartridge opens, and the spermatozoa rush out. Later they commence journeying again of their own accord, and on reaching the turn of the road scale the large egg shaft. The instant one of these mature, bold and adventurous spermatozoa comes across a mature egg at the top of the shaft it fertilizes it. The two unite, nucleus fusing with nucleus in the old-fashioned way. This done, the egg instantly folds itself in a prickly dress like a small hedgehog so as to keep away other over-ardent spermatozoa. As the hedgehog then wends its way backward down the shaft its thorny coat gradually wears off, and little by little the egg becomes enveloped in a pretty, hard calcareous shell that gives it a striking resemblance to the snow-white egg of a bird. In the European snails these eggs are of course infinitely Lilliputian in size with a diameter measuring six millimetres at the utmost. But there are South American land snails that lay eggs fully as large as a pigeon's.

In the meantime, before the eggs reach this stage of development, the parent snail may repeat the whole complicated process of love several times. It develops new love-darts, new spermatophores, and with them new ungovernable passion. Thus new supplies of sperm are brought into the reservoir, which follow the same road until all

the eggs of the season are fertilized. The good snail having thus fulfilled its duties as father, there remain only its duties as mother, which are now pushed forward with the utmost energy. The mother's task is to deposit the mature eggs outside.

The apple-snail mother generally lays from sixty to eighty eggs a season. Before going to work she builds herself a safe cradle. She who never before thought of burrowing now thrusts out the forepart of her body from the shell as far as she can, and digs, or rather screws herself, into the moist soil until she has scooped out a round hole about two inches deep. She then squats down at the top of the funnel, covering everything with her shell. It takes from one to two days before the whole brood of eggs is laid. Scarcely is the work completed, when the solicitous mother covers the cradle with its soil to remove every trace of it. A month later the young issue blithely from their cradle, full-fledged and ready for free life in the open air.

Another sprout on one of the rungs of the ladder from the starfish to the Madonna. Instead of the cruel pictures of savage sacrifice to the germinating young, you now see a living mother's touching care for her developing offspring. A mother's care, overflowing sexual love turning to new purposes—the transition from passive death to active life, another index-finger showing the way in which love swallows up life in death, and higher forms of love cancel death and elevate it to higher life.

Let us conclude the picture of the love of the snails with a wild scene rising from the water with a true dithyramb of the most extreme love energy.

It frequently happens even among land snails that, instead of two enamoured snails, three meet. All take part in the love drama until the contest is decided in favour of the two that have succeeded in best adjusting their bodies in each other.

You remember the story of the little liver-flukes. From the bile-ducts of the sheep the young animals migrate into the body of the pretty water snails of the genus *Limnæus* inhabiting our ponds. There a new brood of flukes grows up in each tiny fluke, crushing the mother or the nurse internally. Before the dead mother's skin is burst open, another brood of still more minute grandchildren flukes germinates within the minute flukes. This pyramid of horror

piles up in the interior of the snails, the snails not concerning themselves in the least about it.

Let us now turn our attention to the snails themselves, and let us see what love pyramids of their own they pile up.

These swamp inhabitants are genuine snails. Like the garden-snails, they are hermaphrodites. Instead of having but one genital aperture, however, they have two, a male near the tentacle, and a female somewhat further behind near the respiratory cavity. This extreme subdivision gives rise to copulatory complications, which far exceed even those of the garden-snails.

The first consequence of this specialization is that when two snails unite in copulation one acts only as male, and the other only as female. Each snail, therefore, though a hermaphrodite, is not simultaneously both the receiver and the giver. It embraces its consort in such a way that its male aperture presses against the female aperture of the other snail, their union being merely that of male and female, with the fertilization of the ova of but one snail as the result.

That would really be simpler than in the garden-snail, if the peculiar construction of the generative organs did not give rise to further complications. This is what happens—one snail treats the other as a male. Consequently, its own female opening situated farther behind takes no active part in the process. There now appears on the scene a third snail, also prepared to function as male. It finds the free female openings of the second, and joins itself in it. The second snail,which from its own choice is only a male, is forced to act the part of a female to the third. This again leaves free the female aperture of the third, and presently a fourth snail makes its appearance in the capacity of a male. Finally there is a whole chain of snails performing the marriage rite at the same time. The snail that has arrived last is the only one remaining free on its female side. As the concluding member of the series at one end, it is the only one acting as male alone, while the first member of the series at the opposite pole functions only as female. All the intermediate members of the chain are active males and passive females simultaneously.

Now add to this grotesque arabesque the awful drama that is possibly unfolding itself at the same time in each of these snails, the iterated birth of flukes within flukes, and you will get a pretty good idea of the significance of the phrase, "the wild creative power of

nature." If you are strong enough to look nature in the face, you must feel going through you a thrill of the sublime as mighty as when the ocean roars, or as when an avalanche thunders down from a mountain slope. It is the ocean of life surging before you, the avalanche of inexhaustible becoming sliding over you.

§ 10

Take a spider; give it the rigid glazed eyes of a shell-fish, the moist, slippery softness, the folds and wrinkles, the absolute nakedness of the snail; smooth away the joints from its legs, so that they resemble intestinal coils, winding and curving irregularly and dragging along the thick sack of the spider's body by clinging with a sort of mysterious suctorial force to the bottom, now here, now there. As for the rest, leave the spider all the savage traits, all the aggressiveness, all the preying qualities of its own nature, leave it its strength and tenacity, its intelligence, which makes it master of all situations. And, last of all, make it as large as a fist, a head, an ox, or even a whale.

You have before you the cuttle-fish.

The cuttle-fish undoubtedly bears a strong resemblance to the spider. But it is no more spider than it is a fish; it is not even akin to the spider.

It is a mollusc directly related to the mussels and snails, a tribal brother of the oyster and the apple-snail. But it has outstripped its cousins by far. Break an egg in which a little chicken has just commenced to hatch, and empty the contents upon a plate. It is a dreary-looking, jelly-like mass of indefinable shape, lying on the plate as if dead. Contrast the formless thing with a grown-up hen, looking at you with an eye which comes from a brain and goes back to a brain; see how it runs, scrapes, cackles and flies. This approximately is the relation which a mollusc, such as the oyster, a low animal and a degenerate besides, bears to the other highly developed mulluscs, the cuttle-fishes.

The cuttle-fish is the crown of its race.

A well-developed brain centralizes its nervous or physical forces in its head, and although its soft body possesses very little skeleton, a special cartilaginous ring, a sort of skull-case, protects its brain as in the higher vertebrates, frog, bird or man. Such a skull would certainly never have developed were there not something worth while to be protected. But intellect is always connected with the

power of free and easy movement. This may be fairly laid down as a law. Accordingly, the cuttle-fish has far outstripped the oyster in mobility also. It is a swimmer, a runner, a climber, in fact, a builder. It barricades itself with stones, where, in its element, the sea, it looks for its kind. In external form only does it still exhibit a trace of the legacy inherited from its ancestral stock. There is something baroque, something grotesque and uncanny in its structure. Its arms are above its head, over its eyes, and around its voracious mouth. They seize their prey by fixing upon it their rows of sucking-disks, from whose grasp there is no escape.

The monster is the more startling on account of its size, which sometimes reaches colossal dimensions. The largest type of cuttle-fish is the giant squid, the sea-serpent of the fisherman's tales, of which there are specimens reaching a total length of sixty-five feet. A spider of that size would be the most formidable of all land animals and the bogie of all nations.

The cuttle-fishes are very, very ancient. They are found in huge numbers almost at the point when the curtain rises on life in the earth's history. The whole intelligence of the mollusc race seems to have centred in them from the earliest epoch. Of all the animal forms we have so far considered they are the most "psychical" or possessed of the greatest amount of soul. But theirs is a savage robber soul. Their intellect is concentrated upon reckless combat with strangers as well as with their own kind.

In such an existence of perpetual, though wise warfare, it may well be supposed that love, too, is not an idyl. In point of fact, the love of the cuttle-fish is a sort of sample of its chief characteristics. Its intellect, its robber nature, are mirrored therein, as well as that legacy derived from its mollusc ancestry which gives it its uncanny appearance, as if it were nailed together from a number of impossible pieces.

Conceive the purpose of the sexual act to be not merely to convey the seminal fluid into the body of the female. Think of it ending in a catastrophe such as this—the male organ, with fearful jerk, tearing itself away bodily and disappearing into the female vagina never to return again. That actually is the situation in the cuttle-fish. Even its external love manifestations are fierce and savage enough.

Sexually, too, it is a highly developed animal. There is nothing of that hermaphroditism about it of which the snails offer such rich examples, nothing of the crude random discharge of sperm as in

oysters. The cuttle-fish has separate sexes; there is a cuttle-fish man and a cuttle-fish woman. With their long arms they seem as if created for the tightest embrace in copulation. And to such union they proceed when in the proper mood for it.

In the magnificent basins of the Zoological Station of Naples, where many a timid animal of the deep has had to reveal the most intimate secrets of its heart, you can conveniently observe the love combats and marriages of the cuttle-fishes.

The whole tribe of cuttle-fishes may be seen there in all their freshness, naturalness and wildness. Not the remotest comparison with the poor eremites of our inland aquaria. In Naples it is really as if you were sailing through the blue waters in Jules Verne's submarine boat, with transparent windows all around. There darts the squid, the swallow of the cuttle-fish family, the freest swimmer upon the high seas. The squids make you understand why the mind of the people, which always sees realistically, has connected these molluscs with fishes. They shoot gracefully through their element, now here, now there, like slender sea-robins or herring, with the black of their large, staring eyes the only other colour in the rose of their bodies, their short, sucker-bearing arms compacted as into a sharp sterlet snout, their broad triangular lateral fins, like the ray's, paddling in the undulating water, free, blithe, airy, sovereign, resembling real fishes, not the crab-like, plant-like, uncouthly inflated, water-pumping creatures of the deep. Next to these red birds of passage are what may be called the brown grouse of the family, little, stout cuttles of the genus sepia, crouching near the sand bottom. In their soft bodies they have a calcareous shell, the "sepia," well known from its use in furnishing limy material to canary birds and in the preparation of metal polishes and tooth-powder. Its ink is the basis of the pigment sepia, from which the painters derive their colour. From its former use in apothecaries' shops it comes by its name of the "officinal" cuttle or *sepia officinalis*. At first you don't see it lying on the seabottom, indistinguishable from the sand, like a real grouse bathing in the hot dust. But suddenly it starts up like a frightened bird and glides through the water. Then it is a droll little beast, a sort of miniature elephant head, chopped off short and rounded behind, the snout formed by the rolling together of the arms into one mass, as in the squid. In its diminutiveness it is a fantastic joke; were it the size of an elephant, it would be a terrifying monster, the like of which does not exist.

You soon observe that the funny creature has the faculty that makes the chameleon famous, of changing colour. Quick as a flash it can distribute certain pigment-bearing cells over its skin, and concentrate them again, so that the colour vanishes. In the sand it is a drab brown, like a hare. A sudden start, and the elephant in the water becomes a black-striped zebra. The new colouring is assumed for effect. The drab brown at the bottom was protection. The zebra gear is threatening rage, spectacular colour, as in the irritated turkey-cock. Do you see another elephant placidly rocking itself in the water high above? Is is a "she, the one whom the little he-zebra loves and over whom he has kept jealous watch from his concealment in the sand? One of the other gentleman cuttles down in the sand has just exhumed himself from his hiding-place and with the most innocent air in the world, like a dreamy boy, has begun to rise upward toward the region of the she. Quick as lightning the legitimate suitor dashes after him, turning into a furious zebra. "Come on, if you dare when I am in this condition, glittering daggers from every stripe." The rival, seeing himself caught, loses his keenness for the love adventure, and drops down as quietly as he has come up.

Quite a bit of higher love-life. A claim to individual possession, rivalry, a play of emotions readily comprehensible to us human beings,—all this taking place among those blunted elephant heads of the most impossible shape. Involuntarily we recognize that their love-history is another step nearer our own, and so more intelligible to us. But what form will the love-act itself assume in those distorted bodies? In the little sepia elephants, as I saw them in Naples, the enamoured manikin came up to his spouse a number of times, then drove her flirtatiously before him, and finally stopped, head opposed to head. He aimed at a real embrace. You remember that in the cuttle-fish family the legs are on top of the head, and to make an embrace possible they must incline their heads, as if offering each other their crowns. For some time the lovers remained still and motionless in this most intimate interlocking of heads and arms. So their marriage rite seemed a decent enough affair. A much wilder story is told of the large types.

Two love-lorn "sea-serpents" in an aquarium, so an observer relates, seized each other and began a dance together as if for life or death. The beasts rocked half freely in the water, like a spider swinging on its web, the supporting web in this case being formed

by some of the long arms which clung with their suckers to the glass pane and to the stone wall of the tank. Their stout bodies thus freely balanced, they interlocked the other arms into an inseverable ball, as if fastening upon prey. Their eyes sparkled, their round paunches took on a uniform dark-brown colour and turned and twisted and inflated themselves with such vehemence that the water was violently agitated. The tussle lasted more than an hour. Now the one, now the other partner was recklessly squeezed to almost the bursting point; now one arm, now another, firmly fastened by suction, was violently snatched away and its skin torn into shreds.

Little wonder this is so monstrous a creature. For, like Solness in Ibsen's "Masterbuilder," the copulation of the cuttle-fishes, considered in its details, makes the impossible possible.

In contrast to the mode of copulation in other animal forms, such as you have just fully observed in the garden-snail, the inner copulation in most cuttle-fishes involves the introduction of a portion of the male body into the female body. There is no doubt that this method is rather well adapted to the securing of the end, but there is no doubt, too, that it has its shady sides.

The more complex animals become, the more they develop into large, freely-moving machines, the more inconvenient this process of union. In the whole of higher animal evolution we see a general, vital tendency leading away from fixation, from clinging and rooting to one spot. For this reason, because it no longer sticks firmly to its abode, because all its life it moves about as a free individual governing its own destiny in accordance with its means of protection, is the cuttle-fish placed so far above the oyster. In the highest of all animal tribes, the vertebrates, we no longer find any form regularly attached or rooted to one spot. In all instances, however, the copulatory act constitutes a last point where such rooting or clinging still takes place, even if but for one moment. It is clear that such an arrangement is calculated to give rise to any number of the greatest inconveniences and impossible acts and situations. We surely have a right to say of this intermezzo in higher animal life what Helmholtz said of the eye of man: "No matter how much I might respect a mechanic for his general accomplishments, I should dismiss him in disgrace as a bungler if he offered me an apparatus with so many defects of omission and so many unnecessary encumbrances." Yet these "impracticalities" of nature are instructive. They show that the world of animal things is not the result of

creative wisdom according to a preordained plan, but of a process of infinitely slow, difficult "self-making" through countless evolutions. All the same the little fiendish relic of inconvenience remains. In the cuttle-fish, the encumbrance of a regular inrooting of the male into the female in the act of copulation seems doubly great because its power of motion has advanced so far beyond the oyster.

Cuttle male and cuttle female have their sexual organs where the whole is brewed, deep inside the body sac, closely connected with the other entrails. The cuttle male has his testicle (one only) in which spermatozoa are manufactured, the cuttle female has her ovary (also but one) which produces unfertilized eggs. Sperm workshop and egg workshop, each has its true opening through which the product can be brought into circulation. The rational thing would seem to be for the cuttle male, in that horrifying embrace which has been described, to apply his sperm aperture to the female egg opening and so bring about fertilization.

But, alas, the process is not so simple. And here we must take account of the confused and strange structure of the body of the cuttle-fish. The cuttle-fish has its normal head above, recognizable by the two staring eyes and the snout around which the legs are arranged. The remaining part of the body is a simple, outwardly continuous sac, which, when the animal runs head downward on its legs, extends upward like a large round ball. From the pattern of other higher animals, we should expect at least one other opening at the end of the sac serving as an anal orifice and genital aperture. But the end is round and smooth as an apple. Under the head, however, on the ventral side there is a cleft which closes voluntarily, similar to the gill-cleft for breathing in fishes. Near the cleft projects another little opening like the mouth of a tube. Both the cleft and the tube lead, next to each other, into a remarkable hollow inside the body which descends like a pocket along the belly. If we open the pocket we find that the body of the cuttle-fish consists of two sacs, an inner real body sac containing the entrails, testicle, or ovary, etc., and an outer skin sac which envelops the inner sac like a loose mantle. The apparent pocket is nothing else than the open cavity on the ventral side between the true body sac and the outer mantle. It is into this cavity that the sexual workshops, situated deep inside the body, open from the inner sac through real holes. If, therefore, in copulation the male sperm is to be introduced by some organ of the male cuttle into the place where the female eggs

are contained, then the male organ must be introduced through this cleft or funnel into the large cavity. This, you see, would necessitate an extremely long copulatory organ.

But the complexity of the situation increases when you find that the cavity and its outer opening usually serve other important functions. In the first place, they serve the purpose of breathing; the gills open into the cavity and are washed by the sea-water which enters through the cleft and provides the oxygen. The cavity, moreover, is an extremely ingenious swimming apparatus. It takes in water through the cleft; the cleft then contracts firmly and the water is forcibly expelled through the little tube near it. The powerful reaction drives the light cuttle-fish backward with the rapidity of an arrow. A temporary obstruction of the cleft as by the intrusion of a male organ would, therefore, as you can readily understand, come into collision with the most important locomotor mechanism as well as with the respiratory function. Humanly talking, the result of the latter alone would be as if the woman's air pipe were also to serve as a vagina and that in copulation the male organ were introduced into the glottis.

But, as has been said, the cuttle-fish makes the impossible possible.

On a first superficial view, it seems that the cuttle male has no sexual organ at all, neither a long nor a short one. His body sac seems to be one continuous apple like that of the cuttle female, with cleft and tube, but without any intimation of a special male apparatus. For this very reason the observer of the fearful love combat of the cuttle is treated to an unexpected spectacle. At the very height of the embracing act the male suddenly sticks one of his arms into the female cleft, and the female takes the whole arm into herself as if it were a copulatory organ.

The arm is a copulatory organ.

For lack of such an organ in the ordinary sense, one of the arms of the cuttle-fish is arranged to receive the spermatozoa in special skin folds or hollows. At the given moment it thrusts itself like a huge medicine spoon into the cavity of the female body and pours the precious life substance into the appropriate place, where the ovary opens into her cavity. To what extent this act of transmission is accompanied by sexual emotions on both sides is difficult to determine. Certain it is that here, too, as in the snails, calm ensues immediately upon the introduction of the arm, indicating apparently

an emotional relief, the supreme accomplishment. But mechanically the act cannot be a very gentle one; for it remains a fact that the arm must literally crawl through the female air pipe.

Presumably it would be of extreme advantage were the obstruction of the path of breathing to be removed as quickly as possible. And it is doubtless the tendency to the rapid removal of the obstruction that brings about the climax of the act.

In a number of cuttle-fishes the copulatory arm simply tears off the moment it enters the female body and drops entirely into the cavity like a swallowed-up bit of prey, while the mutilated gentleman quietly goes his way, as if that were the natural order of things.

But this is not yet the end of the blood-curdling love-drama. The torn-off male organ turns about in the hollow of the female body like a worm, and the first observers, among them the great Cuvier, really took it to be an intestinal worm in the body of the cuttle, and baptized it with a pretty name, hectocotylus, the worm with a hundred suckers.

The female oviduct opening now lies there below at the disposal of the hectocotylus, and he can go leisurely about his work of fertilization. It seems as if a little cannon had been introduced into the interior of the female, automatically firing shot after shot, a love Gatling gun, which the male simply had to set up like a good mechanic and could then leave to do the work itself. In point of fact, just as a modern machine gun throws not merely simple iron balls, but explosive shells that turn each shot into a whole shower bath of devastating iron pieces, so this erotic cannon, the hectocotylus, spits not merely single spermatozoa but sperm cartridges, real sperm canister shot, longish objects, filled with a mass of spermatozoa. The moment this sperm canister shot rebounds the highly ingenious locking device in front breaks, and the elasticity of the wall causes the shot to be explosively expelled as from an infernal machine.

Of course, no mature egg can withstand a purposive cannonade of shot and shell such as this. Despite the endless round-about ways, the great mystery which we have so often witnessed at last accomplishes itself, the *mysterium magnum* of nature to which all roads lead, even though they twist and turn in the most impossible mazes, the mystery by means of which the individual passes into the species and into the life of the millenniums.

§ 11

An entirely new picture.

Beautifully coloured butterflies flitting across the fragrant meadow, flowers at large, moving unrestrained in space with the force of animal vitality. Under the shady wooded roof in the mysterious twilight of the ancient pines, creatures small in size, but wonderfully dainty in structure, stirring about. They are animals which dwell in cities, lay out streets in their forests, possess a sort of language, a sort of morality, live not singly but together in a firm federation of states, and have entered the cattle-rearing and agricultural stage of civilization.

We feel we are approaching the large rift in the clouds where animal becomes man. But it is not yet man. We are not even progressing along the line from which man has arisen. We are following the third divergent arm in the higher story of the animal kingdom, the next highest story that has opened in the course of the endless periods of time during which this old planet earth has existed and borne life, and next only to the last and very highest, which was to grow into the human kind.

It is the line which reaches its summit in the ant.

Eliminate man from the earth and the narrower animal series related to him, the fish, the salamander, the lizard, the bird and the lower and intermediate mammals, and the ant would probably be the intellectual crown of the entire terrestrial globe. One can readily imagine a planet in which such a condition prevails. The whole solid earth of this planet transformed by the work of millions of years into cultivated land. Large cities with domes and buildings of the most various forms. A net of radiating straight roads, uniform cultivated fields stretching endlessly to the horizon, broken up now and then by pens in which a peculiar kind of cattle is fed and now and then milked. The masters of this civilized planet not two-legged, upright-walking human beings, but much smaller, six-legged creatures with peculiarly segmented bodies—the ants of those highest species which exist even to-day and which live in large social

groups. They construct magnificent buildings, cultivate useful grasses or grains, pen up aphides or plant-lice like cows, protect them and milk them of their honey-dew, and require nothing but absolute freedom of competition and the necessary amount of time to transform the entire planet into "their work" as civilized man has transformed it into his.

You know the ant, though you may perhaps not be aware of the fact that it stands so high in the scale of evolution. You also know the butterfly. Ant and butterfly are insects.

The word insect is derived from the Latin *insecare* which means "to cut into" or "notch." They are animals exhibiting cuts or notches in their body which divide it into several distinct parts. At every step you meet with insects besides the butterfly and ant. The fly that has just settled on your nose is an insect; the cricket singing on your hearth is an insect; so is the phantom black cockroach that forages at night in your kitchen and pantry; so is the faithful flea to whom nothing human is alien; so also is the bug that would fain share your bed with you; the plant-louse sucking your flowers at the windows is an insect, and the graceful red lady-bird that eats the plant-louse and that you, in conformity with the ancient custom of man to reward his benefactor with the cross, mercilessly crush to death as an alleged "enemy of the flowers." As an apiarist you cultivate insects in the beehive; the green grasshoppers, who carry terror to none but a schoolgirl, are insects; likewise the hornets, two of whom are said to be enough to disable a man. The stout termite or white ant, which in the tropical countries builds domes 195 inches in height above its own nest, is an insect; and so is the delicate damsel-fly, the little blue sprite that accompanies your boat along the flower-fringed meadow stream. The terrible phylloxera, too, the vine-pest, death to the bottle on your dinner table, is an insect.

In their internal structure they are all very similar, as if they had been run in the same mould, a mould, however, almost the very opposite of that according to which your own dignified person is constructed.

You are a so-called vertebrate and you belong to quite a different type of animal from the insect. The element of size is the least important. The bat, as true a vertebrate as you, is, as a rule, no larger than the largest butterfly, the cinnamon Chinese atlas-beetle, related to the celebrated silk-spinner and measuring nine inches. Even if

insects were as large as man they would still, in all essentials, preserve their peculiar character.

In the interior of your body is a firm bony skeleton supporting the soft parts like a wooden frame in a soft clay figure. The muscles are arranged on the outside. In the bat, in your dog and cat, in the hen in your chicken yard, in the lizard on your garden wall, in the fish on your table, the structure is exactly the same. They are all, like you, backboned animals or "vertebrates," so called from the most important part of their skeleton, the backbone or vertebral column.

As for the insect, it has not the least trace of such an internal bony skeleton. Instead, it has an external skeleton known as the "exoskeleton" or "dermoskeleton," a hard integument formed by the peculiarly solid consistency of the skin or cuticle. The cuticle is inlaid with a horny indestructible substance called chitin. This chitin armour interwoven with the skin connects deep down with the inner tube work of the insect body, thus imparting to it a large degree of firmness, even though to our way of thinking the chitin crust does not seem really "hard." To us a gnat is almost the type of softness; yet looked at from its own small point of view it is invested with a hard, solid dermal skeleton.

Furthermore, along your back you have a spinal cord passing directly into the brain above the gullet. In the insect the corresponding nerve cord lies on the ventral side. Thus, instead of a spinal cord running dorsally through the spinal canal, the insect has a nerve cord along the ventral side, which divides in two and passing to the right and left of the gullet, embraces it like a ring or collar, and then forms a sort of brain above and in front. Inversely, in you the heart is situated in front in the chest opposite the spinal cord; in the insect the heart is at the back. Add to this that you have four limbs (no mammal or bird or reptile has more), while the insect has six. All in all, the difference between you and the insect is so great as to preclude the possibility of man's direct evolution from an insect, even though it be an insect as wise as the ant and with as enormous a brain. All that could develop from an ant is a "superant" with a brain as fine as man's; but it would have a dermal skeleton, a ventral nerve cord and a dorsal heart. Whereas the ape with its endoskeleton, dorsal spinal column, and heart marched straight in the direction of man and required only a powerful brain really to become a man.

The groups of animals to which the insect is most closely related are of quite a different sort.

You are sitting at work. Suddenly you look up, and you see two contented animals dropping down from the ceiling of your work room. They descend on long threads, apparently engaged in very important business, with no concern for either God or man. Now, for a second, they are together, and now they swing apart again. One of them, as swiftly as an arrow, producing the impression that it swallows its own thread, whirrs perpendicularly to the ceiling. A short while afterwards the other follows suit.

A spider couple playing love.

The spider is not an insect. It permits itself eight legs instead of six, and in other respects also is strictly individualistic. But when tested by the standard of the backboned animals, it is, in its ventral nerve cord, its dorsal heart, its chitinous skeleton, an out-and-out insect type, so that you must class it as at least very near the insect group. The same is true of an animal which in our zone is harmless, but which in the tropics has a poisonous bite and the pleasant habit, moreover, of dropping its obtrusive length of more than nine inches from the ceiling of the traveller's hut into his food. The millepede. Further, there is the scorpion. And finally, perhaps, one of the greatest humourists among animals, the crustacean.

The crustacean belongs to the class of creatures that the layman as a rule knows least of all where to place in the zoological system. He is regarded as a solitary type. As a matter of fact, in many ways he is so independent a fellow that one would gladly grant him that rank. Yet it cannot be denied that normally he shares his most important characteristics with the insect, spider, scorpion, and millepedes. Nor is it material that he apparently has the habit of living exclusively in the water, especially in the sea, where almost no insect ventures. It is not altogether so. The crustaceans dwell not only in the spring in your garden but even behind barrels and boxes in your damp cellar. There lies concealed one of your dear old household friends, inconspicuously grey and without any inclination to make your acquaintance by light of day, the sow-bug. The sow-bug is nothing better nor worse than a dwarf crustacean, which has strayed on to the land and is doing its level best to breathe air. It is one of the most remarkable animals in our household; though on that account we do not pay the more attention to it. You will find no difficulty in reckoning the sow-bug as in some ways still close to

the insect, or at least to the thousand-legs. You may, therefore, treat the crustacean, the crab, lobster, etc., from this point of view, especially since they clearly illustrate what is meant by an exoskeleton. In the crustacean the chitinous skin by the infiltration of carbonate of lime, has become as hard as bone so that in the large lobster it is necessary to use a hatchet in order to reach the soft parts inside. In the large lobster the chitinous parts extend into the stomach, so that they may be said to have a skeleton in the stomach which masticates the food as if with teeth.

In the structure of their bodies, the insect, spider, scorpion, millepede and crustacean correspond so closely to one another that they have been united into one tribe or branch called arthropods, just as mammals, birds, reptiles, amphibians and fishes are constituted into one class of vertebrates or backboned animals. Insects are the highest sprout of this branch, crustaceans the lowest. But even within this branch all the main groups have not developed in a direct line, one after another. On the whole, we shall no doubt have to derive the arthropods from the worms. That group of ringed worms to which the earthworm and the leech belong is still so closely connected with them, that many naturalists with much good reason class them together in one main division, the articulate animals. The crustacean may have been the first to develop at a very early period from the worms; then, independently, the millepedes, which in their external appearance still closely resemble worms. A direct, very instructive transition form from the worm to the millepedes survives to the present day in the so-called peripatus of the torrid zone.

From the millepedes may have descended, at least in two independent branches, the scorpion and spider on the one hand, the real insect on the other hand. But this question, too, is not yet definitely settled.

Thus we have drawn a very rough Ariadne thread through the labyrinth of grotesque animal forms. And along this thread, beginning at the bottom, with the crustacean, we shall now have to make our way again in the quest of love.

I presume you know four species of crustaceans and can tell them apart. The fresh-water crayfish, the red hero of the European table in the months without an "r," May to August. The lobster, really a big, salt-water crayfish. The shrimp and prawn, the dainty, fairly

transparent lobster elf which supplies the gourmet with such a solid bit of caudal delectation. And the crab, the odd imp that enlivens every sea-shore.

Four species. Science counts about eight thousand. And all love, or, if extinct, once did love in the springs and oceans of the past, which are no more.

Of course, the main burden of the love-song of the crustaceans as well as all the arthropods is the same as the one we have heard repeated over and over again. Two sexual animals, male and female, the male with the spermary in which the semen with the sperm-cells is produced; the female with the ovary in which the egg-cells form. Copulation brings sperm and egg together, and out of the fecundated egg arises a new animal. The pattern seems wearisomely simple, a perpetual *leitmotif* which we feared might become monotonous and tedious.

But out of this simple theme Nature produces, ever and ever anew, stupendous wonders. Eight thousand species. Could we test them all for the most diversified tale in their lives, reproduction, we should surely obtain, not a thousand and one, but eight thousand tales, so absorbingly interesting that no sultan would fall asleep over them.

Here an important matter must be taken in account which from now on, the higher we rise in the evolution of life, will be found true not only of the crustaceans, but of all animals. As observed in connection with the snail and cuttle-fish, the life-stirrings of the enamoured individual become more and more enlivened with what is usually called "psychic" animation. The crustacean and, much more so, the ant are beings that display quite a different love animation from the leech, not to say the tapeworm. To use a somewhat more realistic word, as we ascend the ladder of evolution love becomes more and more a matter of the brain.

When it is said that intellect and sexual passion are mutually exclusive, that love is stupid, that it is an intoxication depriving a person of his best faculties, the statement is applicable at best only to man, in whom conscious control and blind natural instincts have for some two thousand years stood in a sort of critical opposition to each other. Yet even of man it is true only in a one-sided and limited sense.

In the evolution of animals, on the contrary, the brain and the sexual apparatus are seen to be inseparably connected in an interrelation productive of highly advantageous results. It is love above

all else that requires a brain, and, inversely, there is no doubt that the more mobile, the more active and circumspect the life of the species grows, with all that pertains thereto (care for the young, etc.), the more manifest is the development of a "brain" for co-ordinating those actions and for reacting as purposively as possible to the most varied external demands.

Brain animals are more refined love animals. That is an incontrovertible fact.

And so, as we ascend into the regions where the brain begins to be powerful we may expect new and more interesting manifestations of love throbs in plenty.

I cannot describe the love-life of the crustacean more fittingly and agreeably than by a creature which in the hey-day of its existence is all love, though exhibiting it in a form, which, I suppose, will not be to every man's taste.

It is the root-barnacle.

The root-barnacle belongs to the animals that I cannot describe offhand. You must try, as it were, to enter into its very being.

Imagine a sort of red frankfurter sausage with no joints or limbs, but merely an opening. In the interior of the body no intestine, no heart; only ovaries with an opening which seems to be the female sexual gate.

The grotesque sausage does not swim about freely in the sea. To obtain it, you must first catch certain of the most familiar crustaceans, the common shore-crab, for example. In one or another of these you will find our unreal red frankfurter sitting firmly on its short tail under its belly (in the crustacean what is commonly known as a tail is really part of the hind body). It would seem to be a special sexual organ growing out of the crab's body, while in reality deep inside the crab's body is its own regular old-fashioned sexual apparatus, either male or female; and this thing sticking firmly on the outside is decidedly foreign.

What you behold now is horrible in every respect.

From one of the long sides of the sausage, a branching braid of filaments, precisely resembling the root of a plant, bores itself deep into the crab, winding about the intestine and the liver and—it cannot be otherwise—sucking at those organs and drinking the nutritive juices, just as you saw the tapeworm doing. Thereby, of course, the crab is robbed of some of its rations, though the dangerous root gnawing at its liver like the beak of the Promethean eagle does not

seem to jeopardize its life—no more than in most cases the huge parasitic tapeworm endangers a man's life.

Sausage and eating-braid together form the "root-barnacle."

It is, therefore, a crustacean just like the crab itself, except that it leads a parasitic life on and in it. By way of comparison, think of a man into whose belly another tiny man has firmly eaten his way, into whose abdomen he has chewed a hole, and about whose intestine he has put an extremely long tongue with which to suck up his host's pure nutritive blood. The little parasitic man requires no stomach and intestine of his own, no nutritive organs whatever. As a matter of fact he has none. The only thing he has in his body, which is as empty as a sack, is a reproductive system.

I said a "tongue." In reality the terrible processes that the root-barnacle, or, to use its Latin name, the sacculina, buries in the poor shore-crab, like a life-long, never-tiring dinner-lifter, is not its tongue but its alimentary canal. The noble creature can no more lay claim to a mouth than to a real stomach, and therefore has no tongue. In order to understand how the eating barnacle comes into being you must first see to what group of crustaceans it belongs. That will explain why even in its sausage and root stage it must be regarded as a true crustacean.

The root-barnacle belongs to the order of crustaceans called cirripeds.

In their youth the cirripeds can hardly be distinguished from other young crustaceans. They swim about merrily in the open sea. To be sure, they are not yet mature, they are still a sort of larvæ. But the larvæ speak of the true crustaceans to be developed from them. One day they undergo a strange vicissitude.

The young cirriped crustacean, after living a happy and active life, finds a promiseful spot, generally a log of wood, or a coral, or sometimes even the thick skin of a living whale. Instantly it stands itself on its head and develops from a special gland called the cement-gland at the antennæ of its head a hardening secretion with which it literally glues itself, head downward, to the chosen spot, and thenceforth remains fixed there like a vegetable. In many cases the end by which it is attached is extended into a long stalk, finally giving it the appearance of a thick flower. But from the cleft (in reality a slit-like space in the shell) protrude the curved cirriform legs of the crustacean like the stamens of a bursting flower.

To discover the crustacean in this firmly fixed cirriped animal has caused zoologists much racking of their brains.

The phenomenon itself was long known, but not its nature. In the simple lore of the people the opinion has become stubbornly fixed—Allah knows how—that the mysterious buds seen hanging in thick clusters with long, red peduncles and blue crowns were a mysterious kind of bird's eggs, from which, by a sort of spontaneous generation, arose the barnacle geese. The absurd sacculinæ seemed to have the effect of depriving men of their senses. However, sober, scientific investigation finally succeeded in fishing out the crustacean in them, and all that now remains of the superstition is the name, "goose-mussel."

The sacculina represents a special case of the life of these head-down cirripeds. It, too, sweeps freely through the water—a regular crustacean larva, which apparently may as well turn into a shrimp. But one day its Damascus arrives, and it, too, stands itself on its head. Instead of choosing a ship's side or the thick skin of an old whale, no more yielding than wood, it looks for a nearer relative, the crab. It aims not merely to attach itself to its host; nor does it glue itself on with cement. It creeps under the crab's tail, never forgetting to choose a very young one, and places itself in the closest communication with it.

It sinks a sort of hollow style into its host's interior, and through this style works a good part of its body into the body cavity of the crab, at the same time casting off its larval envelope.

Think of one human being attaching himself to another with a hearty kiss, then emerging from his own skin, with a push thrusting himself into the other's mouth, and disappearing inside. Not so easy to imagine, but won't you show your good will and try?

Having arrived in the interior the wicked little root-barnacle weaves its horrible braid around the viscera of its unwilling host, and snugly installed, sucks the crab's vital juices to its heart's content. Its life inside the crab lasts almost two years. In the circumstances it requires no organ. The crab, which obtains its nutritive juices by laboriously hunting for its prey and eating and digesting, streams over, as it were, into the barnacle; hunting, eating and digesting for the barnacle as well as itself. As in the case of the tapeworm, there is only one independent activity left to the sacculina—to love.

But that cannot by any means be accomplished within the crab.

The barnacle, it is true, has sexual organs, originally even rudiments of both the male and the female organs. But you know the old inexorable law—no self-fertilization. In fact, the male organ degenerates long before there is any possibility of its utilization; and in the full vigour of the barnacle's sexual life it feels itself exclusively a female. What is to be done? It pushes backward and outward again, and the larger part of its formless body passes from the crab, leaving the suctorial root filaments alone in the interior. The comical, flapping, red frankfurter sausage appears on the outside with ovaries and female sexual opening.

A new question now arises. Where is the sacculina to get its man? I have purposely refrained from mentioning the male barnacle before. If you imagine him attached to the hind part of a crab, the question is, How do the two parasites get together for copulation? Perhaps you think two crabs must first meet for the copulatory act, and while the love of the mobile, large animals takes place the two little ones dragging behind them simultaneously fulfil their programme. A very good idea. But a new misfortune arises. The crab infested with the root-barnacle is, as I have said, not altogether killed, but its joy in life and its vigour are so reduced that it does not love. The situation would be desperate were it not for a special dispensation, a dispensation which can only be regarded as in the logical nature of things in so generally crazy an arrangement as that prevailing in the animal order of cirripeds.

The cirripeds, together with their most indolent brothers, the root-barnacles, are a fabulous race, and it is just like them to spend the best part of their lives standing on their heads, and yet the strangest thing about them is their love-life. Were it not for the fact that so extremely careful an observer as Darwin laid the foundations of our knowledge, we should scarcely believe it.

As a rule, the crustaceans of the cirriped order are, at least in their tendency, hermaphrodites, as you may see even from the root-barnacles. The mature animals, such as the goose-mussels, being fixed, you would think their mode of reproduction is that of the oysters, spermatozoa and eggs voided alternately and finding each other in the water or under the gaping shell. Apparently, however, this method was not adequate for the barnacles. Inbreeding through self-fertilization was of course also to be avoided as far as possible. And so we see the following exquisite sample of erotics.

In many cirriped crustaceans there are beside the bisexual her-

maphrodites special males that produce semen alone. As in the celebrated bonellia, they are very small, so tiny, in fact, in relation to the hermaphrodites that they settle upon them like parasites, like a sort of fish-lice. "They lodge upon the hermaphrodite," Darwin picturesquely expressed it. Small as are the hermaphrodites themselves, the males are actually invisible to the naked eye. In their structure they often consist of almost nothing but a living male sexual apparatus. They are male love-individuals in the boldest realization of the word. Sometimes two and more of these dwarf males settle on a hermaphrodite individual, fondly solicitous for their large sister lest she fall into the dangers of inbreeding through too exclusive self-fertilization.

The behaviour of the hermaphrodite, which is at once the host, the carrier and the sexual mate of its other half, is different in different species. Either it continues its work of producing both eggs and sperm even after the dwarf males have announced their presence and simply permits the males to contribute foreign male sperm to its household through the scuttle in the roof of its hard body, thus at least greatly minimizing the danger of inbreeding. In such a case the males are called, according to Darwin, "complementary males." Or the hermaphroditic animal has insight. It understands what it is offered so liberally through the hole in the roof, and puts a complete stop to half of its productivity, namely, the making of sperm. In this event all the eggs enjoy fecundation through the foreign dwarfs. And since the disused sperm apparatus of the large hermaphrodite soon completely decays, the animal which at first was a hermaphrodite really becomes a normal female, a huge female standing on its head with its adorers domiciled on its body like lice.

Thus with the female root-barnacle.

From three to six dwarf males come swimming up and settle at the aperture of her red frankfurter sac. Toward the end of the second year of her interesting and industrious career they fertilize her eggs.

From these eggs there issues (and here something strange begins again) at first a generation of young which become exclusively genuine female root-barnacles. In the spring and summer of the next year a few more deposits of eggs follow, about which it is not known with certainty whether they are even fertilized. From these later eggs develop, at all events not exclusively, firmly rooted dwarf males—a mysterious change, the causes of which have not yet been

explained. More of this a little further on in connection with the bees.

At last, in the winter of the fourth year of its life, the barnacle mother dies of old age and falls from the crab to its large grave in the sea.

An engaging bit of animal life, is it not?

§ 12

O World Spirit, what hast thou been brewing?
So sanely building, so madly undoing!
Throughout thy kingdom's vast extent
All things are crooked, strangely bent;
Save when Man's love and mind cowork.

VISCHER, *Auch Einer.*

In my father's house on the beautiful Rhine there stood on an old dusty bookcase in a half-forgotten corner of the house an ancient yellow skull of a man.

It was found long ago in the vicinity of Roman terra-cottas and among the credulous it passed for a Roman skull. Generations of servant maids, glad to live, were afraid to take it down and clean it; and so it became a free field for as many generations of eight-legged spiders, which came crawling about from the dark corner in the background and built their nests in the skull over the old staring eye hollows. They built new, delicate, soft cotton lids and had their bridal beds and children's cradles within.

When I think of spiders I see again before me this merry spider inn "At the Death's-Head." I am a child and as yet know nothing of love, neither the love of men nor of spiders. The skull seems to me to be very, very old, and the little swarming eight-legged spiders behind their little dusty-grey silk fans very young hobgoblins not concerned in the least with reverend old age.

To-day it seems to me the reverse. Whether the man who bore this skull actually lived eighteen hundred years ago or not, he loved as a man, as a civilized man. But the spider bears a really ancient face, its love is ice-grey as if it came from a different planet. An old, old confusion remains clinging to it, which has never been surmounted.

There is a problem connected with the love-life of the spider, going back perhaps with the spider itself as far as the carboniferous age. It is a problem which really goes to the heart of all loves, and which has not yet been properly solved. I mean the problem of the difference between eating and loving.

Return for a moment to the story of the dwarfs. You remember how love first began. Eating was a necessity even for the firstlings of life, the primitive cells. By the process of metabolism which the cells underwent, eating replaced the continually used-up material with new material and maintained the same body bulk. Beyond the simple renewal of the waste products, however, it also added positively to the body: the body grew. This growth led to the division of the individual into two, to the simplest form of reproduction.

In this sense eating was the earliest prerequisite of love. With the firstlings of life, there was no opposition between eating and love; eating was a purely logical condition of love.

But then came sexual love, and with it the fusing of life with life, cell with cell, egg-cell with sperm-cell, nucleus with nucleus, chromosomes with chromosomes, hereditary capital with hereditary capital. From this fusion there arose a heightened growth, a richer more-sided possession. Thus sexual love with its union was, to a certain extent, really a sort of higher eating.

Higher eating! With a very striking difference. In simple eating the organism doubtlessly took in "dead" nourishment, whether in the manner of plants, it directly took in inorganic, mineral substances, and elaborated them, or in the manner of animals, killed and ate already existing living cell substances. In either case the organism possessed the power of transforming the dead material which it ate into living building material. But that was something subsequent, something which life evolved as a new creation of its own, and cause of which is to be sought more closely in the mystery of metabolism and growth. The fundamental fact remains that "dead" material in the ordinary sense served as food.

In sexual love, on the other hand, life coalesced completely with life. life devoured life as such, if I may be permitted the language, which I should like to keep at least on the border-line of concrete imagery. Or it allowed itself to be eaten by it, which comes to absolutely the same thing; for in the process of sexual union neither side is destroyed, both unite into a richer life, which thenceforth embraces the characters of a double heredity.

You see that here, too, there is logically a certain connected chain. Nevertheless it also contains the kernel of a certain antagonism. Now pursue this matter higher up in animal life only. Here the contrast soon had to assume a sharp critical edge.

The plant took for its simple nourishment generally inorganic,

mineral substances alone; for its "love nourishment" it took the nuclear substance of a related plant individual. Though there was a difference in the two substances there was as yet no possibility of a conflict. Now in the animal kingdom there arose that other method of eating. The animal required cell substance even for its simple nourishment (I leave breathing out of account here and regard only the stomach). It is true that it did not require actually living, but newly killed cell substance. If there are plants then of course the simplest and most natural thing is for the animal to take vegetable substance. For its simple food, it sucks, plucks, bites up and digests plants. It becomes a vegetarian.

Even here there is, to begin with, still no conflict with love, although in itself the difference from that of the plant method is extremely great. For its ordinary purposes of nourishment, the animal eats plants by accustoming itself to violently desroy the life of the plant. For love purposes, on the other hand, it "eats" related living animal substance, not destroying it by any means, but fusing with it in peaceful union with the absolute preservation of the life of both. You see the contrast is a mighty one. But still there is no conflict.

The conflict comes with the following situation.

Many animals accustom themselves to take as their "simple nourishment" organic dead substance no longer from plants but from animals. Animals begin not only to copulate with animals in love, but also to seize animals when they feel the pinch of hunger, to destroy their life by biting them up or in some other way, and then eating them as simple, legitimate, nutritive food. Now you have these two situations. On the one hand an animal looks for an animal in order to unite with it alive in the greatest harmony. And on the other hand an animal looks for an animal in order to appropriate it as organic substance, kill it beforehand, confronting it, in a word, in absolute disharmony.

Now the animal kingdom has not gone out of existence. It has, on the contrary, developed to the spiritual grandeur of man. Which is sufficient proof that that conflict is not tantamount to the gallows. Certain helpful conventions arose, which on the whole proved efficacious in keeping the animals from exterminating each other, just as conventions arose to effect the evils in the dangerous conflict of inbreeding about which I told you above.

The more animals split up into fixed individual species, the more

it became a fixed secondary law in love matters that in "love eating," in sexual union, brothers and sisters are to be avoided and "strangers" looked for, but the strangers must belong approximately to the same type of animal. The frog may not love a fly, the starfish may not love an oyster. This offered a certain solution. An oyster can love an oyster alone, a starfish a starfish, a fly a fly, a frog a frog. But as to eating in the general sense, a starfish may eat an oyster and a frog a fly. Be it, therefore, a law (at least as much as possible, that frog never should eat a frog, nor starfish starfish, so that eating and loving may never conflict. On the other hand, a starfish may eat an oyster, a frog a fly. In other words, individuals of the same species should limit themselves in their intercourse to the beautiful harmonious love variety of eating, but in relation to different species, let the destructive common form of nutritive eating prevail freely. It cannot conflict with love, since love does not take place between individuals of different species.

But even such laws do not suddenly drop down from the sky. It had to develop and crystallize laboriously and painfully through countless difficulties and extremities. Often it worked very defectively and hesitatingly. In a certain sense it may be said that for a series of animal groups, the law existed only theoretically. They only half-fulfilled it in practice, thus proving the rule, at least, by the exception. There are animals even to-day which have remained as if petrified in their habits on the border-line. Nothing is more startling than these fossilized habits. Instead of being buried in the rocks as old bones they continue diligently to live on and on as living beings. And yet there is in this life, in this definite, tenaciously preserved mode of existence, the face of a Wandering Jew, which points deep down to where things first began to develop. It is as if a bridge had begun to be built. When the first cut of the spade was made a man was there who was put into a hypnosis. To-day the bridge stands a complete structure in resplendent light. But below, at the abutment, the man is still standing and holding the spade, turning over and over again the first clod of earth. This man is the spider.

Figuratively speaking, the spider is not as yet able fully to comprehend that the object of one's love with whose life one should unite into the most ideal love feast for the good of the species, must not at the same time be greedily ogled as a fat morsel of food for the profane every-day use of the stomach.

Spin, my daughter, spider spin, your suitor is coming your love to win.

A strange daughter and a strange courtship, indeed!

There is the spider female and the spider male, both of the garden-spider genus.

The male spider deserves to be placed second because it is considerably smaller than the female, only about two-thirds her size. It is a beautiful morning in September. The ripe sunflowers stretch their golden arms to the clear blue September sky. Asters glow in the grass like red and blue double stars. Across the old decaying green fence is the sombre pine wood, the crown of its trees topped as if by grey smoke, a vanishing fairy tale. On the fence here and there is a large cobweb. The spiders have been carrying on their existence here for many months, man and woman, each for himself, inapproachable, hostile even to the neighbours of their own kind.

Every one of these spiders is in the hey-day of its existence. It has a long life behind it, a life full of vigour and work, long only in the spider sense, which measures time from a different angle of vision than you, not even one whole year according to your way of thinking, not even one revolution of earth around the sun.

But for the spider it was a cosmic year. It divided itself into two large epochs. First a terrible ice-age, winter. Then all the spiders lay in a half sleep in tiny eggs, hundreds of yellow little eggs together in a warm egg nest.

Then came a new wondrously changed day upon the earth. The snow melted away, green buds sprouted forth. It was spring. The sun knocked against the egg nest, and the little spiders burst their egg skin. For eight days more they suffer themselves to remain together in a social mass. Then the sister swarm rushes apart, each for itself, with never a thought thereafter for any of the others.

The spider knows no larval existence like that of the higher insect, the day-fly or butterfly. It quits the egg as it is, except that its colour is not complete and it is very tiny. In its cobweb it then grows through the summer to the full size of the terrible robber animal that it is, to the fat garden-spider or cross-spider, which frightens even you. Of course, it is only unheard of voraciousness than can effect such rapid growth. Under the lash of hunger the spider in a couple of months becomes a veritable expert in animal killing.

It is only for this purpose that the magnificent cobweb is con-

structed. Victim after victim falls into it. All its life from May to September is an orgy of slaughter, of eating for nourishment. Extraordinary capacity and intellect all concentrated upon this one task. Pure hereditary capacity, the general tendency to construct nets; and then a very high degree of intellect peculiar to each individual which enables it to seek out the proper place for the cobweb, appropriately alter it to answer the many special demands and find over and over again the best and most suitable conditions for it. It has the faculty to estimate the value of every prey, it knows its own power, knows how to reckon with wind and weather. There is a true little spiritual halo around this tiny but keen and closely concentrated brain. But it is always devoted to one object, eating in the service of simple growth, eating with what it involves, killing, the inexorable destruction and annihilation of the lives of others.

It is a wild hunt. The robber baron forever lying in wait for his prey. Whatever chances along is seized, if only its power permits. It goes on and on, bent upon only one purpose, to grow to a certain size. A moment ago it was a fly that fell in the cobweb, and gave up its life-blood upon the altar of this purpose. Now it is a smaller spider of the same variety as itself. What cares it for relationship! The smaller spider is seized, the lasso is thrown around it, it is bound and sucked out. A male spider it was, the males being smaller. What is sex to it! Hunger. Eating. Growth. In five months it grows from a little droll yellow dwarf to a large monster. That sanctions, that explains everything. If the table is especially rich, then it eats for the purpose of storing up a reserve. The stomach has special pouches, which, when not used, hang like empty sausage skins. But sometimes they are filled almost to bursting with stored-up provisions, previously consumed with savage greed by the sucking gullet, and then slowly elaborated by the intestine below, part by part, one sausage after another.

Autumnal gold, September blue. And then the great change, the great destiny. Growth? The day is here when the spider's growth is complete. Its purpose seems to be fulfilled. The position is gained. The stomach has done its duty. But how? Behold, this whole growth was not an aim rounded off and complete in itself; it was but the foundation for something higher. No sooner is it fulfilled than this higher something begins to manifest itself. The full-grown, mature body suddenly sets free in its reproductive organs sexual elements. Eggs in Mrs. Spider, sperm in Mr. Spider. Sud-

denly the new invisible thread of an obscure longing weaves itself from sperm to eggs. All the eating and devouring, all the savage disregard of the lives of others has resulted in the love yearning for the life of another as life.

Now begins among the spider folk what is shown in a tragedy on the grand style as a conflict of duties. Man and woman are accustomed to devour any approaching individual without mercy, unless it is too despicably small. No quarter is given, not even to a fellow spider, not even to a male fellow spider. The female spider knows this actively; the male knows it passively. She knows that the thing to do with a little spider manikin, if he is foolhardy enough to venture near, is to enmesh him in her threads and eat him up as a desirable prey. He knows that he must be well on his guard against fat Madam Spider and avoid her energetic proximity for the love of life. And now the conflict—love. The two are to come in contact with each other "in love." They must seek each other out.

These crusader spiders, as all spiders in general, have strictly separate sexes. The male has two long sperm sacs in his body, the female two grapelike ovaries. Here is no simple random reproduction without direct bodily contact, as among the lazy oysters. Such a thing is possible only in water and among animals settled in communities close to each other. There is no way out of it; the two must come together.

The sexual organs, hidden deep in the stout hinder part of the spider's body, open, both in the male and the female, in a simple gate on the ventral side not at the very extremity of the body—that is the seat of the spinning organs. The normal thing then would be for the male and female to agree upon an interval of peace for this one exceptional instance and to get together in the web of the one or the other in such a way that gate should touch gate. If it were only not so dangerous. Of course, the one who is most afraid is Mr. Spider.

Now were he really to dare to propose to her and climb into her web—a rebuff would mean more than merely a wound inflicted on the heart. He who fails to win her is enmeshed not in the threads of the heart but in very real hempen cords; and then no rosy kissing mouth for him, but a grimly real, terrible knife snout, which makes short work of him. But the autumn sun is laughing and a yearning is stirring in his soul; yonder rocks the loveliest spider queen in her silver net. He must venture—for death or for love.

But before he can start out, he must go through an extremely difficult operation, as an indispensable preliminary to courtship.

You saw how the cuttle-fish carries its spermatophores in one of its arms. There is a comical-looking, half-crab-like, half-spider-like little animal at the bottom of the sea, the so-called sea-spider, whose legs likewise play a very decided rôle with regard to the sexual apparatus, both the male and female having a sexual organ in most of their many legs; and since both eggs and sperm issue forth directly from their long spider legs, it may truly be said of these phantom leg animals (the scientific name of the group is *pantopoda* or "all-legs") that in them the entire process of reproduction normally takes place leg upon leg. Each gentleman spider at the garden fence proceeds somewhat after the same fashion, except that he must first actively prepare, so to speak, what the sea-spiders are provided with by nature.

Look what he is doing. He does not yet go to the female spider. He first has some matters to attend to on his own person. His sexual opening is a simple aperture with no trace whatever of a copulatory organ. As he is sitting, rubbing his body on a tiny bit of the cobweb, and moving it to and fro with the hind part, anxiously reflecting—shall he or shall he not cross to the spider queen—behold, all at once the semen flows out of itself from the little opening and falls in a tiny drop upon the cobweb. Immediately our spider shifts his position turning about so that the lower part of his head in the region of the mouth can touch the drop. It seems as if he wants to eat it; and if he actually did, it would cause the greatest possible confusion in the rivalry between simple eating for the purpose of nourishment and fusion or the "higher degree of eating" for the purpose of love. But it does not go so far.

Nevertheless, you see the drop disappear in the immediate vicinity of the mouth as if he actually ate it. This is the situation. You must try to get a vivid picture of the extraordinary relations of the mouth in the garden-spider.

The spider's mouth is the normal front opening of the digestive apparatus through which food enters the stomach just as in the case of yourself; it is therefore a cavity. Around this cavity there are, for the purposes of seizing, killing and reducing the food that enters the stomach, strong movable jaws, just as you have for the same purpose a movable lower jaw and two rows of solid teeth.

The jaws of the spider, however, look somewhat strange and are

very different from yours. The reason simply is that they still betray, in an unmistakable manner, their origin from legs.

Yes, from legs! Both the upper and lower jaw of the spider are really nothing else than a pair of little legs, each situated at the head in front near the opening of the mouth. They are legs like the four pairs of true spider legs usually so-called, situated further behind. Remember. The spider, like all the higher arthropods, is descended from certain wormlike creatures whose entire body, including the head, was divided in ringed "segmented" parts, and each of these rings originally bore a pair of legs. The millepede still faithfully represents this stage, although it is no longer a worm but stands very near to our spiders, in fact is perhaps the direct ancestor of the spider in some of its primitive relations. In the spider itself not even the head and breast are any longer separated. Everything in it has fused into one. The only genuine old worm segmentation left is a deep "constriction" between the cephalothorax (head-breast) and the rest of the body.

But even so the legs remain numerous. Though head and breast were united into one, this one body still had six pairs of legs. In the compact concentration of the body from a long worm to a stout spider this number was far too great, more than was necessary for running. And so it gradually came to pass that only four pairs were actually used as legs. The first two pairs entered more closely in the service of the mouth in their immediate vicinity; they contracted from long clutching and ambulatory legs to clutching and biting organs of the mouth. They simply became jaws. If you look at another articulate animal, still more highly developed than the spider, which must also have descended in a parallel line from millepedes and still earlier from true ringed worms, an insect, say, like the beetle, you will see how there the process has gone even further. In the beetle three of the six pairs of legs have been transformed into jaws, and there are only three pairs of running legs instead of four. The beetle has six legs instead of eight, like the spider, but it has three kinds of jaws instead of the spider's two kinds. The fact that the spider has preserved eight legs is evidently due to its need for two "spinning hands" to make its cobweb. With this bit of Darwinism you will now be in a better position to understand what our gentleman spider is about, although it is a remarkable enough performance for all that.

Although the spider's jaws about the mouth function primarily as

true jaws for the purpose of nutrition, yet in small ways they have faithfully preserved their general form of limbs (legs or arms, whichever you wish to call them). It is conceivable that occasionally they might also serve other purposes. Think of it in a human way. Instead of jaws with teeth, you have four little arms around the mouth, two above and two below. The upper arms fit firmly over each other like teeth, and work like teeth, too, in a way, grinding over and against each other. The lower arms and hands bob freely outwards, and may, on occasions, still perform their special function of arms.

It is exactly so in the spider. The little mouth-legs or jaws are jointed as in the human arm, in fact, more complexly. Each of the inmost parts (say, the upper arms) fit firmly over each other like real jaws. The lower ones (say, the lower arm and hand) extend under and up like fine pointed extremities of these true jaws. The upper portions end in a little sharp tooth each, in which a gland secreting a malignant poison opens for paralyzing the seized victim. The lower project on each side as rather long feelers or palps, which, if we are to pursue the image of the human mouth which is necessarily very defective, may be compared to two protruding lip points swinging about freely while the spider chews heartily further inside.

Yes, and what now? With the points of the lower jaw our spider seizes his own drop of semen, which he secreted in solitariness, and absorbs it. The lip point is perfectly formed for that purpose; it receives the semen in a cavity as in a small provisional reservoir without in any way bringing it too near the large mouth in the background. Imagine yourself, roughly speaking, rolling your lip downward and holding a pencil between it and your chin. This is the way the spider male holds the semen in the apex of the outer jaw, with the sole and praiseworthy object, of course, thus to present it to Madam Spider, and at the same time deposit it into as foremost a place as possible for her dental region.

You will be able soon to satisfy yourself that this is actually what he wants to do, and to observe the way in which he does it.

Taking his life in his hands, he boldly crosses to the edge of Madam Spider's cobweb. She, sitting in the middle, large and stout, notices him. There are now several possibilities.

She may not like him personally. He may be of a certain dangerous size, not large enough to impose, not small enough to fail to arouse her appetite; he may not be handsome enough or not marked

with sufficient distinctness. In short, for some reason or another, he is not to her taste. In such an event, the case is desperate from the start. The woman waylays him like a fly.

But fate decreed otherwise. The spider looks her suitor up and down and she is well pleased in him. She climbs slowly down from her throne and proceeds to the edge of the cobweb where the male waits modestly. There is no doubt of it, she too feels the stirrings of love. The overwhelming universal love passion puts to sleep for an hour the individualistic eating passion. With her back down, her head forward, her legs straightened out stiff, Madam Spider suspends herself in her net and awaits Mr. Spider. Will he be Siegfried? Or will he fare like poor King Gunther, whom Brunhild on the night of the wedding bound and hung on the wall?

But she does not make her decision yet. There is a new possibility. Several waiting and hoping males come to one spider. The proportion is generally one woman to a dozen men. There is danger of rivalry. Unawares, while he is still in doubt as to what purpose the heroine harbours in her bosom, good or evil, the hero, as in the case of the cuttle-fish in the aquarium, sees himself attacked by a rival suitor. There is strife, defence, combat. The heroine waits. Who will conquer? Surely the victor is the more energetic. It is the judgment of God. It so happens that our spider is the stronger. The rival withdraws. Now from war to love.

Carefully, very carefully, Mr. Spider approaches his lady with his back down like herself. Now he seizes her body with his legs. She suffers his blandishments. For fairly a quarter of an hour he merely strokes her like a man trying to soothe and pacify a shy animal.

Trustworthy observers have witnessed a sudden catastrophe even in this last quarter-hour of preliminary fondling and caressing. Absolutely without any foretokening, as if the common eating instinct had suddenly mastered her finer love hunger and submerged every other feeling, the female spider broke loose, and in a jiffy seized the male spider like a poor sinner, entangled him, bit him and sucked out his vitals. Among certain spiders where the males are especially tiny, the little spider Gunther, by way of precaution, leaps at one bound on the back of his threatening Brunhild, and it is only when he has gained that position that he begins to caress her. It is the safest place, since Madam Spider cannot get hold of the little fellow up there even if she should suddenly desire to do so. But

these manikins, being so minute, have nothing to fear from the female anyway; she will not touch him because they do not measure up to the traditional size of a respectable morsel and are not worth while enmeshing. But our case is not yet so regulated.

Here the situation now reached is still beset with danger. It is the absolutely incalculable situation showing more distinctly the conflict I mentioned above, the problematical, the uncertain element in the life of the spider depending upon a turn of the instincts.

Nevertheless, at the height of this fearful crisis the male, evidently driven by an impulse which he can no longer control, ventures upon the decisive step. With a quick turn he flings himself around, and sliding over the female hanging in the net from above, jumps toward her and confronts her body to body. At the same moment the extremities of his palps or lower jaw, which carry the seminal freight, are thrust into the female vagina. Strangely enough there is at the vagina a sort of regularly protrusible copulatory organ which receives the semen.

This is the moment of true copulation, lasting about half a minute. As quickly as he came he jumps away with a backward leap. In fact, he now withdraws entirely from his Brunhild. It is only after a quarter of an hour that the play is repeated once more and several times thereafter, apparently until the male has transferred the very last drop of semen to the right spot. It seems that the female spider can bear any supply she gets. For the semen she receives passes entirely, or at least partially, into one of those excellent reserve depots, the so-called seminal receptacle, in which spermatozoa can be preserved alive until all the eggs are mature, perhaps even until they are laid. After she has deposited her eggs, you see her squirting something upon them. Evidently it is some reserve semen she pours over them—a comical parallel to the way in which the manikin first squirted out the semen for himself in preparation for the copulatory act.

The last act, really the epilogue of the whole tragicomedy, the relation of the spider to her offspring, is from the standpoint of the higher evaluation of love touching beyond all measure. It shows, in an instinctive form, the germ, the emergence of the noblest side of our highest love-life.

Problematical as sexual love and marriage are in this terrible life of the spider, its motherhood already appears in absolute purity devoid of all conflict. To it is devoted the whole brief, remain-

ing period of the autumnal life of the spider. With expert skill the mother makes a nest of the finest texture for her eggs. After she has deposited them and carefully fertilized them further in the manner above described, she spins the nest together and then—the last task in the life of the old spider—guards it and defends it with jealous care.

The hatching out of the young no longer falls within the earthly destiny of this faithful mother animal. The sunflowers wither and break, the asters shrivel. The "ice-age" sets in once more. Winter and the end of the world.

The young no longer need any protection. Slumbering in their thick coats they do not feel the cold, and sleep away happily until the spring. The frost has exterminated the enemies that might have proved a menace to their safety, the same frost that kills the aged, faded mother spider. One day she is found lying near her brood, which no longer needs her, a starved frozen autumn leaf.

Do you see the eyes of the Madonna shining over the old green garden fence? Do you see her endless wanderings through the millions of years from blood to spirit? The savage spider female grown big in a carnival of carnage and murder, hesitating still whether or not to kill off in cold blood the male who proffers her his love, as she killed all his predecessors that fell in the murderous pit—and the mother who watches over the cradle down to the very last breath of her life. From these contrasts nature has forged what you to-day call love.

§ 13

Woman is bitter. . .

Skip from the spider fence at the pine wood to the seashore for a moment. I must tell you another story right here next to the spider's for the sake of contrast, although it takes us into a totally different field. Let the arthropods for the time being sink into the blue of the world's mist. We shall come right back. This is merely an intermezzo, from another distant animal branch—a tale about vertebrates. The gastræa became a worm; and the worm here became a crayfish, a centipede, a spider; and there, a primordial fish, a lamprey, a shark, a sturgeon, or say a true fish, a herring. You remember the herrings, and how they loved. Dive down for a minute with me among the relatives of the herring, into the emerald deep swarming with fish. Again there is a sounding conflict. And here, too, the eyes of the Madonna.

I had an acquaintance whose entire philosophy of life was summed up in the verse, "Woman is bitter." In his worst moments he speculated as to whether woman were not entirely superfluous, a handicap to civilization, perhaps just conjured up spiritistically to walk beside man, like an evil shadow of his enlightened spirit, a phantom that aped him; perhaps, in the Darwinian sense, merely an inferior species, which man drags along with him like a rudimentary organ imposed on him by some ancient misfortune of evolution. Then he would launch into Utopias as to how man could be saved from "woman." He dreamed of absolute social segregation, of a "mankind" consisting of nations of independent, strong-minded men; and here and there, as isolated as possible, a kind of huge gipsy encampment, where this creature "woman" would stay. Now and then it would be man's onerous duty to occupy himself for a brief interval with this foreign world, but only from a sense of disagreeable duty; and therefore he would seek to get it over with as quickly as possible. Then he would come home to the real great kingdom of the intellect, as a civilized man returns from the North Pole. Bringing up the children would be exclusively the concern of the men.

The future was bound to bring something like that to pass, he said; no doubt about that. And it was a proud sensation at least to know what the future had in store. . . .

I see him yet as if it were to-day; a little wizened old man expounding all this to me in a grey tone of voice. It was a rainy day, and the water came streaming down. I kept thinking of Ovid's "Metamorphoses" and wondered what the wit of that jolly old poet would have turned this embittered son of earth into.

Your body, my dear fellow, which your bile has already shrivelled up, would be shrunk to the tiniest dimensions of three and a half to four inches. You would grow a dainty little fan-shaped tail behind you, your legs and arms would become fins, and your back and body would be suffused with a delicate green and silver, shining like scales. All your grumpiness of soul and your contempt of "woman" would stick out of your body in a few long razor-sharp spikes, spines so murderous that even the fiercest shark would try to spit you out in horror, without succeeding right away, because you had bored into its gums as a hedgehog bores into a dog's nose.

All in all, you would become one of our funniest fish, the stickleback. And this not merely as a punishment for your stickler's soul, but because the stickleback, deep down in the silent water, has already materialized everything that you hope from that woman-hating future.

Alas, our human dreams are so tenuous! We build the grandest Utopias, with a new heaven over a fool's paradise in the year 3000 or later. But nature actually did it all long before us. Nature gave it all a try-out and passed it through the sieve of experience during long vanished thousands of years, but weighed it and found it too light to embody in the great luminous line "from animal to man." So that to-day it merely stares at us like some hoary relic out of a musty corner. . . .

The male, and only the male, is the hero in the life-epic of stickleback dom. The female at best is just an episode in it. The male is the representative of the whole ethics of the race, existing not only as an individual pursuing its own individual aims, but as a citizen of a higher community perpetuated as a species through the millenniums. The female is really nothing but a roving gipsy, living a free and easy life without any duties on her conscience. To make all this possible necessitates a very involved novel, whose plot is spun in the green depths of the sea.

Mr. Stickleback has a snarling, domineering, envious temperament. He is forever fighting with his own kind, and only when a big common foe, a finny beast of prey, which does not happen to fear the spikes of the little monsters, or does not know them, bobs up in the neighbourhood, does a temporary sense of solidarity appear in the whole gang of these little stickleback roughnecks for the purpose of common defence.

The "female" in the sense of a lovable creature, not to say of a faithful companion in fighting and work, does not exist for this brigand-souled, spiked individualist. Occasionally, on a marauding expedition, it may fall in with the "women folks," who as a rule keep out of the way, in a separate group, usually near the surface of the water, while the males prowl in the depths. Instead of love, they at once engage in quarrelling, fighting, sticking and stabbing, until either the male chases the females and cheats them out of their prey, or else a particularly powerful female gets to him with a knock-out jab, and he slinks back to his own domain in disgrace like the hunter who has been gored by a stag.

So it is in every-day life. But there comes a time when stickleback, the man, feels a strange stirring within him, that agitation which breaks out so decisively in the life of animal creatures. Certain individual cells have separated from the great cell-complex of the male body. At one place inside the body a substance has collected in which countless small cell individuals clamour for liberation, for ejection. The semen's instinct is powerful; it will out, in order to extend Mr. Stickleback's individualistic existence and make him partake of the life of the species, the immortality of the race. It is the solemn moment when youthful headstrong "contempt of woman" is wont to change radically into the grand passion, the joyfully painful seeking and finding of the eternal feminine!

Our Mr. Stickleback is different, however. The fermenting substance, to be sure, does not leave him cold by any means. Like a choleric man or a turkey-cock whose blood rushes to its head, he had the power even before of suddenly turning the pale green and silver of his body into brilliant, loud colours in moments of violent emotion, in anger or in the heat of a fight. A colour wave would shoot across his belly and turn it quick as lightning into a glaring red, his back into emerald, and the white iris of the eyes into a deep green. Now that a permanent agitation makes all his nerves tingle, these gorgeous colours become his permanent suit of clothes: that

condition now sets in, which one refers to as "wedding dress." But wedding is about the last thing Mr. Stickleback appears to be thinking about just now.

If before he was an incorrigible troublemaker and roughneck, now in his gay dress-suit he is seized with a veritable frenzy of utter contempt for the world and his fellow-fish. His bilious temperament reaches its peak, and the apparent nuptial red is only the turkey-cock colour of the individualistic fanatic to whom the mere sight of a second being is almost enough to burst his blood-vessels, become a permanent institution.

He suddenly gives up his loose marauding habits entirely and seeks out a suitable spot in which to make his permanent abode. Whoever approaches, male or female, he chases away like a madman. But if the coast is clear and quiet reigns round about and he is at perfect liberty to devote himself to the work of a hermit settler, he begins a highly mysterious activity.

First he drags together all manner of material at the bottom of the sea, roots, bits of water-plants, straws and twigs. He tears off suitable pieces and tests them by dropping them, to see whether they are too light and would therefore be carried away by the moving water, or whether they are heavy enough to sink to the bottom and stay there. He selects only the heavy leaves and stalks as available for his purpose. As a starling comes dragging a long straw like a flag behind it, the stickleback, too, is quite willing to take pieces of plants in its mouth longer than his whole body.

At a goodly spot in fresh water (for he lives here as well as in the sea), mostly on sandy bottom where the water is not stagnant but flows rapidly and clear, he piles up his raw material and then with infinite patience combines it, piece by piece, into an extremely ingenious, well put together structure.

The foundation consists of pebbles placed in a hollow scooped in the sand. Above this gradually rises a roundish dome of plant material. The walls grow, the little builder (for he measures not quite four inches and often much less) adding layer upon layer of rootlets and grasses and cementing them together like a regular mason.

His own body furnishes the mortar or cement, and when the layers of raw material lie loose on top of each other, he bends his body over them and secretes thick drops of a sticky substance, which immediately holds the material firmly together. From time to time, when a bit of the vaulted wall happily stands, he hurls himself

against his handiwork to test it and see whether it will collapse under pressure; or he violently beats his fins and agitates the water over and around it, so that by this rude process of selection and elimination all parts that are not nailed down and battened tight come up in the little whirlpool as loose chaff, revealing the gaps that must be reinforced with more mortar.

The whole job appears all the more wonderful, considering that the mason is a fish, having no hands but only crude fins, and therefore literally throwing itself body and soul into its work, by snuggling, pressing, twisting, turning and whipping the water into a little whirlpool or at most helping itself with its mouth, which has a very fine row of velvety teeth in its jaws.

Our hermit's tireless activity lasts for hours and hours. The rough structure alone requires four hours, and the finer trimmings take several days. At last the work of art is finished. It is a substantial dome, the size of a fist, entirely closed on top, and with a side entrance the width of a stickleback. Frequently he strews mud or sand over the completed structure, so that no part of it remains visible or accessible except this opening.

Mr. Stickleback has not built for himself alone.

His intention, in truth, was no hermit's cell. That enigmatical instinct has awakened in him the dark, long-distance vision of an existence beyond his own, a vision of young beings, which his semen must first propagate and by which the species will live on. The cell at the bottom of the pond which he built with such a lot of trouble, is a nest for harbouring the young during their earliest development.

What is peculiar about Stickleback, the male, is that as a future father, he builds the nest quite independently of the female.

It would never occur to Stickleback, the female, to do so. The stickleback women folks still disport themselves in distant waters with gipsy abandon and gaiety, while the hermit, with the dark vision of instinct, has somehow glimpsed the concept "progeny," and true to the inner call of duty he goes to work in the service of the species' propagation.

Now that the nest is finished, the purpose of procreation requires at least temporary traffic with "woman," for better or for worse; "no prayers will help," as Falstaff says.

And so Mr. Stickleback must now bite into the sour apple, drop his hermit's surliness for a while and by some means or other get hold of his unfortunately necessary complement "woman." How he

goes about it does not exactly resemble an honourable proposal of marriage, but rather looks very much like the behaviour of a wicked bachelor, who leaves his cosy quarters to pick up a girl on the street for a very temporary purpose.

Mr. Stickleback swims away from his nest, and after a while comes home with a feminine stickleback; observers differ as to whether he just happened to discover one swimming by, lured there by his nest, or whether he broke right into the female encampment and (possibly thanks to his gorgeous wedding colours) instead of encountering the customary rough reception met with the friendly advances of an agreeable soul.

Once alone with the gipsy, Mr. Stickleback apparently doesn't find it so bad at all. Merrily he wags his tail around the female, which does not seem to know what it is all about. Before the female's surprised eyes, the male plunges through the aperture into the nest, sweeps the interior clean for the last time, and then, by sundry movements, indicates his desire for Her Highness to enter. If the gipsy plays stupid and pretends not to understand, the old ruffian is aroused in him and Mr. Stickleback presses her body rather roughly, tickles her with his spines and lightly beats her with his tail. Into the nest she must go.

If even this fails to help, the bridegroom loses his patience: he can have "more women than one." He brutally chases away this coy one, and goes and gets himself another.

The first one or a subsequent one becomes reasonable in the end, slips into the nest and now apparently realizes what the idea is. She is supposed to lay her eggs in there. . . .

As in the case of all fishes, to perform this act the stickleback female requires a certain degree of sexual excitement, which may have been induced during the long preliminaries of her visit to the nest and which now attains its objective in the regular way. Probably the male adds a last finishing touch by hotly pursuing the female into the nest and rubbing his body against hers. In any event, Mrs. Stickleback quickly drops two or three eggs, but then, with one wild bound, she breaks through the other side of the nest, which thus acquires a second opening, and off she goes, back to her companions, in the free and easy gipsy encampment.

Mr. Stickleback, too, has meanwhile reached the peak of erotic sensations; no sooner is the female gone when he is on the eggs, pouring out the milky semen necessary to their fertilization. From

this moment, he is absolutely not concerned any further about the fate of this female.

All he knows is that those few eggs are not enough by a long shot to satisfy his duty to the species. He not only can but must have "more women." The following morning he starts out again, gets himself a passing bride by the very same technique and makes her increase the supply. He is a total stranger to monogamic ideas. To him, the "female" has only one purpose in life, namely, laying eggs, and he treats these gipsies as if they possessed no individuality whatever, apart from the fact that a few incurably stupid ones who do not know enough to come in and lay eggs have to be eliminated. When the proper number of eggs has been reached, his friendship with females ceases.

Woe to the female, be she one just had or a stranger, who seeks to approach the nest which once more is exclusively the hermit's property. He puts her to flight with the utmost brutality; but his brutality appears in a milder light when one sees that these females are devoid of all maternal feelings and long for nothing so much as to break into the nest afterwards, steal the eggs in gipsy fashion, and eat them—which certainly exceeds anything that real gipsies do to gipsy children.

When this danger is past, there begins for Mr. Stickleback, now a father, a quiet time, spent in the strict but meditative performance of duty, similar to the period of nest building.

It takes about ten days for the tiny young fish to hatch out of the eggs in the dome. The "old man" does not budge for an instant from the next during this entire time. His watchful eyes note and he immediately repairs the least bit of damage done to the little artificial ball by the swirling water. He frequently looks in at the openings or goes into the nest, gently paddling with his breast fins and seeing to it that the motion of the water brings to the eggs the oxygen which their hidden embryonic life requires.

It seems as if the actions of these stickleback fathers were guided by an endless chain of beneficial experiences, experiences which they could not possibly have gained during their existence as individuals and which benefit, not them, but a new generation of individuals in the dark process of coming into being. . . .

The young ones finally arrive—unbelievably small creatures, visible only with a magnifying glass and seeming to need a guardian much more now than they did as eggs in the mud-nest. The father's

behaviour at this stage is touching. He laboriously breaks off the roof over his young brood, but does not by any means let the little ones out into the troubled waters of life as yet. When they grow stronger and daringly venture too far out, Papa Stickleback watches out and brings them home by swimming after them, simply swallowing them and spitting them out in the nest. For quite a while, the little band, closely crowded together—and looking like a silvery flock of cotton in the water, is carefully watched and tended by fat old Mr. Stickleback with his red corporation.

Only when the young have reached a certain size and are able to feed themselves (the very young fish at first eat the yolk sac which they dragged out of the egg on their body) does the old one's lively interest in them expire, and the colony scatters in all directions.

How strong are the paternal feelings which animate Mr. Stickleback has been proved by a mass of details gathered by first-rate observers. A stickleback, which stupidly had built its nest on a part of the beach left exposed at ebb-tide, so that it was forced to leave with the tide, returned each time at flood-tide and repaired the damage. Another stickleback, whose nest had been removed to another basin in an aquarium, continued to look after it on finding it again. This same faithful father went raving mad and died when one of its own monstrous females, while it was battling with other males lusting for booty, destroyed the nest behind its back and ate up the eggs. "Woman is bitter."

You have no doubt noted why I told you about the stickleback right after the spider.

In the case of the spider you had the competition of simple lust for food with erotic feeling, the female menacing the male with her cannibalistic intentions even at the moment of amorous embrace, but then proving an ideal mother. On the other hand, in the case of the stickleback you have the conflict between lust for food and maternal feelings—predatory mothers menacing their own brood, but paternal feelings increasing to the utmost by way of contrast, thereby evening up matters.

In both cases the sexes are far apart; so far that, with the exception of a very brief moment, man and wife oppose each other as enemies, as wild competitors and even as objects of booty in the struggle for existence.

Spider and stickleback stand extremely high above diplozoon and

syngamus in the evolutionary scale. Does it not appear as though higher evolution were aiming at a growing separation of the sexes, at a progressive destruction of marriage and the close concatenation of the sexes? But do not let yourself be fooled by that.

Such cases as the spider's and the stickleback's are still below the plane of marriage. It is true that you find marriage suddenly flashing up with quite undoubted genuineness in the animal world considerably below man, and we shall have a good deal to say on that subject. But where marriage did become possible, it became so only afterwards as a new reunion of two sharply differentiated individuals, each spiritually self-contained, and entirely dependent on itself at first. Such individuals were only possible from a certain stage of mental development on, however.

When this stage was reached, the external picture was bound to look like isolation, like a segregation of the sexual partners. From the crude practice of growing together alive as illustrated by the diplozoon and the syngamus, the evolutionary road leads to the true, helpful community in marriage of two higher animal individuals, getting together socially under division of labour which extends far beyond sex. But this road, dark on all sides, runs through a stage of separation at which the individuals (including those which are sexually dependent on one another) were driven sharply apart, and were each on its own. It was only on the achievement of this sharper individualization that progress could then build of a higher union. And without a doubt there are traces of this intermediate transition stage in the spider's as well as the stickleback's curious comedy of love.

You here see petrified extremes of this necessary transition, even to the extremest of the extreme,—the case where the sexes of the same spider sort have been "individualized" so far apart that when finally it does become necessary for them to meet, a conflict of instincts, of eating versus love, is possible.

But you can see in the extraordinary growth of parental feelings, which break out with positively elemental force, how close you already are, in both cases, to the higher animal marriage which brings and binds together two individuals by the force of an idea, despite this intensified opposition between the sexes.

These feelings, to be sure, appear to be limited in each case to only one sex, but significantly to a different sex in each case—to the spider mother and to the stickleback father. I shall have occasion

to tell you something special about these feelings, at the point where the line of animal evolution begins to be dammed up as it approaches man and gains its greatest force. Just assume for the present that these parental feelings are a fundamental phenomenon of living beings, a phenomenon finding very spiritual expression, just as it becomes clearly visible among animals only when you have gained a certain degree of spiritual insight.

When this new task imposed on the individual was thrust into the foreground it broke the ground for a new bridge leading to higher marital co-operation, or at least to co-operation in a form like marriage, and to the ideal reunion of the sexes side by side with and after the actual sexual act. And this in turn was bound to work automatically against extreme individualization and isolation.

Mr. and Mrs. Spider and Mr. and Mrs. Stickleback are each very sharply defined individualities, going to the extreme of almost complete negation of any feelings of love, any sexual relations to one another, any "love hunger" whatever which would inhibit or check the fighting and food instincts where the sexual partner was concerned. The sexual act, which is inevitable, since otherwise continued existence of the species would collapse like a house of cards, is in these cases narrowed down to a reluctant moment together, to say nothing of the fact that in one case the conflict of instincts made even this unwilling moment dangerous to life. You might well think that this represented the extreme opposite corner from all marital evolution, and yet, in this extreme isolation of the sexes, powerful maternal feelings appeared in the case of Mrs. Spider, and corresponding belated paternal feelings towards its offspring in the case of Mr. Stickleback.

The individual, at the point of emancipating itself from the community of sex, sees itself chained at one place that is at least indirectly connected with sex, to something that extends far beyond isolation as an individual. What if a new necessity for a "double life" developed after all out of this factor? What if the case arose that Mrs. Spider and Mr. Stickleback could not adequately discharge their parental cares and duties alone, and needed a second being for this purpose? The most obvious answer is that the other parental sexual half would be the natural partner for this purpose. Now suppose that, instead of merely Mrs. Spider and Mr. Stickleback building the nest, Mr. Spider and Mrs. Stickleback, too, were compelled to take an interest in this work. Do you see the red strip

which the morning mist, thick as your clenched fist, reveals as it begins to tear apart . . . ?

This would not result in a new syngamus marriage, in which the mates for the duration of their lives are physically united like two sausages grown together, but in an entirely new form of protective association, at first between two otherwise quite sharply differentiated sexual individuals—a protective association for the protection of the young, for nest building and guarding the nest. Then to this new ideal association, which would itself be the external opposite of physically growing together like that sausage union, add the simple love-tendency of male to female, but bettered, heightened, spiritualized, and with absolute mutual respect for both sexual individualities—and you have higher animal marriage. Man is a higher animal!

Let us briefly survey the entire road we have travelled, back to the mists of that old dwarf story. In the beginning, there was no separation into sexes whatever. First, reproduction took place by cell division. Then out of this, by devious and involved ways, arose the necessity of out-trumping simple division with a higher fusing process. Two cells, a little male cell and a large female cell, seek each other and fuse. The single cells become associations of cells. Each association generates a certain quantity of male or female cells for fusion purposes, many-celled male and female individuals of a higher degree make their appearance. Two principles now combat each other in these males and females: the progressive process of individualization, which separates animal from animal, individual from individual, finally male from female; and the old love-instinct which drives both to an act, at least to copulation, to each other, and which at the same time is generally bound to evoke a certain inclination toward a lasting union. The latter principle occasionally gets the upper hand, and cases result running to the extreme of growing together again, such as the diplozoon, which was already hermaphroditic, the syngamus and many others. But there is something retrogressive about the crude attempts in this direction. One of the self-contained individualities degenerates, as the tendril crab's pitiable substitutes for males and the ludicrous Tannhäuser lovers in the green bonellia, for example. Retrogression! The other principle of individualization, which at first tends to isolate the sexes, appears to be the higher road, and on the whole it is. But it is clear that this road too leads to harm, when it runs to extremes. Isolation occasionally goes so far that the two sexes are almost entirely driven

apart, with only reluctant, endangered moments of copulation and no longer any love-life, as in the case of spider mates that eat each other, and the stickleback wife, brought in like a prostitute, and immediately chased away. Something is radically wrong here, but still it is a bridge to higher things, leading over justified individualization and separation of sexual individuals to a new form of association for the care of the young! Parental feelings keep the parental individuals together beyond the moment of copulation. Thereby the good core of that other principle (sexual union) acquires a new, higher idealized power. This free association, in which the parents remain together, on the whole does justice to the individuality of each, and holds good for the period when there are no actual young as yet; it constitutes an absolute conclusion of peace between the sexes, which yet is the diametrical opposite of growing together bodily and which, on the contrary, preserves the colouring of a higher spiritualized social association. This is marriage.

If you look at marriage in this way, from the viewpoint of animal history, you will at once see through certain dangers of a relapse which still exist actively among us to-day—a relapse toward the bonellia or root-crab type. Among these, the males were the degenerated part. In general, a tendency appears to me to have existed from the very beginning for the centre of gravity of greater strength to shift toward the female, and we shall have more to say about this later on. But the female too could play the weaker rôle. In the case of the spider, the female was still the physically stronger, but no longer in the case of the stickleback. In this shifting of the centre of gravity, the fundamental fact remained unchanged, that the fusion of sperm-cell and egg-cell immutably requires two halves which are entire individuals, expressed in the form of chromosomes, and that therefore two individuals must always share and share alike. But the one individual can be a weakling while the other may be in the fullness of its strength. And now ponder the fact that animal evolution one day entered the luminous circle of "man." Do you divine that mankind too must ever carry on this ancient fight, the fight against this foe?

Humanity has gradually fought out a colossal fight with the animal,—with the animal outside man which faced him as a foe on this planet. Humanity has annihilated the wolf and the bear in civilized countries, and now it is putting down the tiger and the poisonous snake. It already holds a victorious position in its hard-

est fight—against bad bacteria. But meanwhile there is a much graver feud continuing in mankind itself; man's struggle to shackle the inherited animal within him in the form of a hundred dangers in his innermost nature. At bottom, one could leave the achieving of success here to natural selection, to the principle of self-regulation in the sense of utility, which ever persists and achieves its purpose. That has helped until now, and can continue to take care of things. But there is a new factor, a short cut in human nature. It begins itself to survey the road with Intelligence; it begins to be its own "Good Fairy Utility," has already recognized natural selection and perhaps will recognize still other effective laws of progress, and it begins to master, apply, regulate and improve these laws consciously. Herein lies the value of deliberately bringing up and unrolling all these primordial happenings of being and becoming for our problem of love-life as well.

In our supreme civilization you hear it said that the human female, woman, is the "weaker sex," inevitably and eternally so by the iron logic of evolution, that we must make the best of this fact and that all that matters is to determine the exact extent of woman's inferiority, so that we could learn to calculate permanently with this faulty apparatus, with this one scale of the balance which is too light, without wasting time in the fruitless effort of gathering fruits from thorns; but do you divine what card is being played here like an eternal cosmic necessity? It is nothing else but the tiny tail of one of these small aberrations appearing again in our civilized life, fortunately only a very small one. That enormously greater physical load placed on the female, connected with the long period of pregnancy, the dangerous birth of the already mature child and the nursing of the offspring, whose historical development will concern us at length in the course of our talk, undoubtedly set in with the mammal, the class in which man has risen to the top. But originally this very factor brought about anything but a degeneration of the female. It awakened a double strength in the female, and steeled the female to be that true miracle of strength which lies in the highest concept "mother." There are no facts to the contrary that man too appeared on the scene with this plus in energy on the female side, which maintained the harmonious balance in splendid fashion despite the actual greater load in the one scale. Think of the performances of women acrobats and ask yourself what cannot be made again, in individual cases, out of the feminine body in the way of

muscular development and perfect discipline of motion? Think of the brains of the poetess Droste-Hülshoff or the mathematician Sonja Kowalewsky and ask yourself if the possibility of their arising looks like mental degeneration. A slight tendency for the centre of gravity to shift lies only without our cultural education, but its span has fortunately been much too short to bring about any deep radical change. And we already see the principle of self-regulation at work. In our time you have everywhere seen joyous progress in breaking down all external, accidental barriers in our social and moral life that sought to block the way for the return of woman's primitive whole strength. An impulsive urge, the wonderful elemental force in Nature which persistently achieves things, and intelligent insight, surveying the field and historically weighing the danger of degeneration, are already victoriously at work here and are playing into each other's hands. Woman feels and sees that she must catch up with something, but that it is far from being too late to do so. Where fermenting, impulsive force and intellect rise up together, it is never and nowhere too late for anything in human nature!

What though it may assume contradictory forms in the universal dawning of to-day. To many persons it seems to-day as if marriage as such were itself to blame for this shifting in the centre of gravity. They believe that marriage must be abandoned in order that the bonds and shackles may fall from the human female, this most valuable female of our planet. That all depends on how you take the concept "marriage"; whether you see in it only a rigid historical tradition, or whether you grant that it has an inner life which throbs and pulses on. I am of the opinion (and I shall have to give you my reasons for it at length in the course of our conversation) that there is a logical nerve in marriage, which we human beings must not sever. But for that very reason I consider marriage as we see it to-day to be an ideal and not a fulfilment. Marriage, too, will pass through us to higher levels. As in the case of all ideals, you must look forward, not backward, in order to grasp it. If the suppression of one sexual being as against the other is a source of harm, a danger, a form of inferiority to be buried again historically, in the eyes of continued evolution and to our own surveying reason, if human strength in its full glory can permanently live to the full and achieve something higher through equal work and performance on the part of both sexes; this higher stage of marriage which is in process of becoming into being must take up this demand as a root of its

strength and as an absolutely necessary prerequisite. And it is my conviction that marriage can do that. For the logic of its origin lay, not in the violation of the one part by the other but in the joint work of both sexes for the benefit of the whole. It was the benefit redounding to the child which originally brought about the separation of the sexes. This child and its advantage (the progress of the whole, therefore) at a certain stage then brought the two sexes together again in a higher community or union. Historically, the child literally created parents as well as marriage. In this whole line of evolution there lies no reason or justification for believing that one of these parents must of necessity become inferior; the contrary is the case.

If, in the face of the boundless demands of the individualism of living men and living women in their short individual life, you wanted to eliminate the idea of the whole, of the child and the further chain of generations entirely, then only would you get from this extreme individualism to the negation of marriage. It hardly needs to be said that this kind of individualism would be the death of humanity, so that this negation would only go tumbling after a corpse. More decisive is the fact that individualism in this form would eternally fail for the very reason that a healthy woman (despite all pangs and pains of child-birth) would never want to do without the child for living out her individuality fully; the child happens to be a part of "living her own life" to the full and is one of the sources of her highest happiness. And lastly, often as it may have been contradicted, this applies to a real man as well. And our whole life, the same boat in which we all happen to be, is on the whole much too wonderfully constructed in this respect for us ever to indulge in a decided aberration from it. On the one hand, this life in its only sure, discussible form, is measured out to us as individuals so unutterably short; just a couple of years long. On the other hand we ever live and labour, may we consider ourselves egoists of the moment as much as we please, during these few years in and with values, works, connections, ideals and hopes that reach out far, far beyond this tiny span. The chances of individual existence beyond death in some form or other waver in the mists of conflicting views (with all due respect to the secret.). It seems at least as if Nature (if we must once more be so very personal) had here systematically and deliberately blocked the way to our understanding. Therefore, immortality through the

child is at the present time the only concrete, tangible kind available to us, and with which we somehow or other manage to hang on to the great golden tow-rope that reaches into eternity. To many people the assurance may not seem sufficient, that the works begun by us continue in our children, that the grandchild still reads the verse that we have written and has pleasure in improving on what we sacrificed ourselves for. In any event it is a ray of light, and one so powerful that without it our existence would be the poorer for something we cannot do without. This indispensability of the child for our strange situation as individuals alone nullifies that other train of thought entirely. And, therefore, do not let the revolt of individualism in our time, no matter how violent and justified, worry you any on this score: it contains its own corrective, which will never let it get entirely away from the ideal of marriage.

The surging flood will calm down again, and opposites will again get into equilibrium. A time will come which will fulfil these things; and compared to ths fulfilment you to-day are only as diplozoon and syngamus, bonellia and root-crab, spider and stickleback. For that reason, do not scorn these old fighters. Learn from them. Do not close your eyes, as if you were observing the old insanity of nature. It is your madness, if madness it be. But if you believe in light, light in the infinite succession of things, light out of which worlds stream like silvery dust, light in you, in your sunlike eyes that drink in the sun, then it is your light, too, which is already twinkling there like a little bluish star. . . .

The stickleback is a fish belonging to the class of so-called bone fish. Very little below this class, man's family tree bent off from the family tree of the fishes, in order to work its way up via salamander, amphibian and reptile to the mammal. The fish developed to the stickleback and remained standing still. The mammal became man. To-day these distant branches of the great genealogical tree clash again. And the one is lord of the earth; his judgment will sooner or later decide the fate of the other. The little stickleback offers the human palate nothing, in fact, many people consider it downright unwholesome. Therefore, man some day will no doubt exterminate it along with its whole strange tradition of love.

Involuntarily you speculate about this for a moment. Suppose the chain of human evolution had run the other way, via the sticklebacks? Suppose man were not lord of the earth as he now is, but were a descendant of the sticklebacks in the watery green?

The stickleback, transformed into an intellectual animal of the very first order, would in the course of all other changes probably have preserved its abstruse kind of love for a very long time in its civilization. What a changed situation that would have been!

The history of stickleback civilization would have begun with a code of ethics, in which the mother was considered to be the natural enemy of her children. A Mosaic law embracing all this would have had to make the sharp distinction here: "Honour thy father, and hate thy mother." And a Wise Man beside stickleback humanity's sea of Galilee who sought to comprehend love more broadly than any one ever did before Him, who wanted to turn all ethics which had hitherto been valid, into its extreme opposite in the name of love, could have found no sharper nor mightier example than this: "Love even thy mother. . . ." The sea of His time would probably have raged and surged in the throes of the wildest storm and would have swallowed Him up because of the temerity of His demand. But they would slowly have had to believe in it after all, with the utmost difficulty, almost despairingly getting accustomed to this idea, just as we have realized or at least are beginning to realize, that we must love all men. . . .

And yet, the really interesting thing about this phantasy is that on the whole it would all have amounted to the same thing in the end. Humanity at one point would perhaps have had to fight a few thousand years more for moral freedom. Stickleback humanity would first have had to win for itself within its own civilization something which our humanity already obtained from the animal. But it would have gained this with absolute certainty! That great proclaimer of mother-love would really have appeared one day. Mother-love is a station on the road of human love. Man was able to start from it. Stickleback humanity would first have to gain this station. But it would inevitably be reached by the identical logical consequence.

And that is really the instructive thing about this whole train of thought, and the reason why I put it in here. There was an inherent historical necessity in the fact that another line of the vertebrate branch striking off from the fish below the stickleback, and not the stickleback and its descendants, should become "human beings." There must have been certain definite reasons in the chain of evolution for this. But the very people who to-day have schooled themselves superficially in Darwinian ideas are frequently inclined and

like to speak of "chance" in evolution as of something absolute. That is nonsense. A little pliable piece of bony material or nerve matter or the tail-end of a different method of respiration or what not, whatever drove the process of human evolution over this way instead of that way, via the salamander instead of via the stickleback, that is all supposed to be chance! And if it had not been for this very tiny spark of chance, we would have had quite a different sort of fireworks at the top!

But what is the truth of the matter? Everything that had been missed would have had to be made up in the end, and the result would have been the same in the end. If "chance" had happened differently it would not have altered the great course of evolution, but could only have brought about a certain kaleidoscopic shift in the order of succession. Certain things which in the former case were achieved at an early stage would now have to be made up at a later time in the latter case, and the contrary would have been true for certain other things, thus undoubtedly equalizing matters.

You understand what I mean, do you not? This extreme way of thinking things out in other terms, in the sense of that stickleback illustration, does anything but make the ground of human civilization's real achievements rock under our feet. On the contrary, such extreme speculation only serves to make it really solid. For only now does our consciousness see the inevitable, the immutably logical "upward" behind all possible positions of the kaleidoscope of external occurrences and "chances." You will fare badly in one case only, and that is, if instead of swearing by evolution at all, you stick doggedly to some idea of an external form of morality, some moral event in the human course of civilization that lies behind us, and in this seek the seal of an absolute "world order" in the sense of something permanently anchored therein.

§ 14

These incomparable, unchainable,
Are always further yearning,
With desire and hunger burning
For the Unattainable!

Faust, PART II

Roll your head in the wild heather, as in a red crown of thorns, your weary human head, burdened with so much philosophy; the head that is supposed to comprehend the world, from the flaming girdle of Orion to the volvox, whose globular world rolls through a drop of terrestrial water.

Do you hear the soft humming of the bee, hurrying from bloom to bloom? There it floats away in the light like a shining mote in a sunbeam; the delicate melody of its wings dies out afar. Philosophy, all is philosophy. There is a world of problems in this little bee in the heather, and the profoundest philosophy of love as well.

Do you know the legend about the saint who complained to his God that the world was too small for his thoughts? Then God opened his eyes to the secrets of a mote dancing in a sunbeam. A thousand years passed till God came again to the earth. And there sat the saint, still staring at the mote in the sunbeam; he was only just beginning. . . .

Follow the bee in spirit, and its soft, dreamlike, delicate humming will grow into a gigantic melody for you. Round you of a sudden rings the epic of love that became a state, of love that became merged in the state; and which, in the rigid structure of a "love state," in the end found itself stopped by an insurmountable wall after all.

It is a melancholy melody at bottom, but mighty as few are. You hardly know it. To be sure you have heard of the bee and its state, of the drone and of the queen-bee, fleetingly, as you hear about a thousand things to-day. For the characteristic thing about our modern education is that it throws countless things at your head, from Orion to infusoria, as words. And everything appears to be finished

with; the things themselves remain strange to you, as if the words had killed them. You know nothing about the real love-story of the bee. You do not know that another infinitely instructive chapter, reaching to the heart of your profoundest human questions, begins here. Hearken, therefore.

There she goes, the little hairy beauty, and there goes another and yet another, from flower to flower, in the well-known bee fashion which every child knows. It is not an idle habit, nor mere indulgence in the pleasures of the table. They are gathering something; they are "working." They suck the honey of flowers here, and water there. Here, flower pollen (semen) gets stuck fast like little pairs of pants on hind legs specially constructed for the purpose, and is carried along in that way, while resin is gathered there. In the first place, just what is a bee anyway?

The bee is an insect.

Climb quickly down the long ladder of evolution again; from the one-celled original animal to the gastræa which had the first stomach; from there, on the left to the polyp, and on the right to the worm. From the worm, several big animal branches shot upward. One led to the vertebrate, to you. Another went via the earthworm to the crayfish, the millepede and the spider. And finally this latter line somehow or other continued to the insect.

It forms the tip of its branch, of the so-called arthropods. Like the spider, it probably got there by the evolutionary road running via the millepede or a similar form. The millepedal arthropod's many legs were reduced to six pairs, in the way I related in connection with the spider. Among the insects, three pairs gradually became eating implements, and three pairs were left over for locomotion. That makes six genuine legs, and by them you can recognize every genuine insect. The wings, which many insects have in addition, have nothing to do with these legs as far as their origin goes. They developed out of folds in the skin of the back, in striking contrast to the wings of vertebrates—birds and bats for example,—which are always genuine forelegs, merely somewhat changed and adapted for flying.

Now picture to yourself that beyond their common original stadium, which the well-known little guest in your sugar still represents for you to-day, the insects very early divided into a number of groups differing considerably from one another. The butterflies formed a group, the beetles another, and the flies, the bugs, the

caddis-flies, the grasshoppers and cockroaches, the termites, the dragon-flies and day-flies are other groups.

And quite incidentally, the so-called skin-winged insects or social insects constituted a group.

The popular mind thinks only of the bee in this connection, but the scientist lumps with the bee everything that's called bumble-bee and wasp, and throws the ant into the bargain.

There is nothing to prevent us from regarding these as the real apex of the whole insect race. And since the insect is the apex of arthropod evolution, with the humming, busy little bee you are at the very top of a towering echelon, beyond which there has been no advance. You can make a daring comparison and say that the bee and the closely related ant, in short, the social insect, is "man" of its division; it is the evolutionary peak among its six-legged ancestors just as you, two-legged man, are the apex of the vertebrate division (of fishes, amphibians, reptiles, birds, and mammals). The only difference is that you as man have on the whole "apexed" yourself a tremendous way farther than even the wisest of social insects.

So much for Darwinism. Now let us get down to love.

That bee over there is an insect of a certain degree; but what is it as regards love? Is it a male? Is it a female? Is it one of those monstrous male females or female males of the race of hermaphrodites? We are encountering something strange here.

You fathomed the cross-spider's eroticism. The spider ranked considerably lower in the division of arthropods. The separation of the sexes into male and female was extremely sharp. And male and female were each an individual, with differentiation carried to extremes—so extreme that marriage was entirely out of the question. They merely met fleetingly for the purpose of copulating, and there was enmity between them from generation to generation.

I told you about the spider for the very reason that it was an extreme case. I said that the renewed sharp individualization of both mates was in itself a matter of great necessity, and that on the whole it represented a bit of inner progress, a bit of freedom. This had to develop first; for only then would conditions be "ripe" for a new movement which would reunite the two sexes. And only then could a higher protective association, organized along freer lines while at the same time respecting that individualization, develop between male and female—actual marriage in our sense.

This latter was bound to develop. I intimated what the probable

natural starting-point was for this renewed progress toward bringing the sexes together, namely, the care of the young. You saw the solitary spider mother, and the solitary stickleback father. Now think of a little pair of birds, which brilliantly exemplify that higher marriage, with both parents feeding and tending the young . . . and you have before you the entire road, which was bound to lead the separated individualists together again.

With the bee you have not yet reached the plane of the swallow or the nightingale, but at any rate you are a good bit above the cross-spider. You know, too, that the bees and ants live sociably together, being far ahead of the spider as "agreeable company"; and you know that they tend their young with great care. You accordingly expect them to be at least a bit nearer to the stage of higher marriage. The bees yonder in the heather are "gathering" something; they want to bring something home. What could be more obvious than that they want to take along their "bag" to their young, to their larvæ?

It so happens that gathering honey is in itself a permanent amorous activity, not for the busy bees, but for the flowers they visit. I told you about the cross-fertilization of plants; how the law against inbreeding prevents them from "mating" themselves even when they have both sexual parts (male stamens and female pistils) in one and the same flower. And how, unable to come together for the act of love, they have happily found an automatic "love-by-mail" service in the insects that come and go. Here the flowers load down the visitor with pollen, and there they stretch out mature female members toward it, eagerly taking off the foreign pollen which is their manna of life. The bee is an eternal courier of love. By involuntarily transporting pollen particles to another flower and scattering them at the right spot, the bee makes up for the fact that it packs up and takes along whole loads of pollen and honey for its own private use. I merely mention this incidentally, to show how the little bee, in the course of the simple sober occupation of earning its daily bread, leaves whirling behind it a veritable comet's tail of other loves. But what about its own love? If it has children at home, many children with hungry mouths, for whom this industrious collecting is intended, it would be only natural that this little bee has itself lively joys of love behind it . . . ?

Go and get one of those honey-gathering bees. It defends itself. It stings, and now it is lost, a sure candidate for death; for the sharp

dagger with which it defends itself and which it leaves sticking in your wound, is no external implement, but a member of its own body, inflicting a mortal wound on the bee in tearing off. Sacrifice it and examine its internal parts, its organs of love, for the answer to the great question: male or female?

You make a strange find, and you almost feel sorry for your victim. As far as love affairs are concerned, you have apparently encountered a poor martyr, one whom life had already branded as loveless.

You can still recognize from its structure that it is a female; a pitifully stunted female, particularly in sexual respects. The organ for producing eggs is stunted and barely recognizable as an ovary, with just a couple of empty stumps instead of the numerous thick tubes which one expects to find; and all the parts which might serve the purpose of copulation are stunted and impassable. It is a vestal virgin by compulsion, cut off from all the joys of mating and maternity. And yet the poor thing gathers honey! For whom?

A touching thought strikes you: itself deprived of motherhood, can it be working for others' children, impelled by the dark urge of the road to the Madonna . . . ?

But what is this? Catching a second one of those honey-gatherers in the heather, and a third, you always find the same sad riddle. They all are stunted and practically sexless; all of them, those hundreds and thousands humming through the woods, over the ridge and in your flower garden . . . all are unfruitful and sexually impotent.

A veil sinks over the happy picture. All nature is intoxicated with love. Every visit of a bee in a ripe flower is a festival of procreation. Beetles, flies, and dragon-flies are everywhere finding each other, seizing one another, and copulating. The bright butterfly is nothing but a wholly liberated elf of love. And the liveliest, dearest, most familiar band to us, the bees, are a poor, sad, grey fellowship of the disinherited, which never had a share in love and never will have. . . . But now let us get down seriously to the question, for whom they do gather honey; if they are all sexless, for what sort of progeny, for whose progeny? And how does their species continue to exist at all?

Stop committing murder and follow this live vestal virgin. She has gathered enough. Loaded to the gunwales, she rises and flies home. Near the green fence, where we watched the spider couple, stand the familiar beehives. They are artificial dwellings, and man

has left it to the busy bees to build the interior structure. Man has entered into a similar relation to the bee, as the bee to the pollen-bearing flower. He expressly gives it help within the framework of its necessaries of life, and in return he continually takes away a certain surplus of its production in the form of tasty honey for his private use.

Our laden vestal virgin disappears through the flying hole of a beehive. She is at home in a wonder world, which solves her riddle —the riddle of the poor sexless creatures. Compared to this fairy tale of nature's, everything that I have told you so far about the realm of love is child's play. Even the tapeworm cannot measure up to it. It is absolutely unique. And if our planet had produced nothing beyond this, no human being, no human paradise and no human folly, it would still be hall-marked as a wonder planet which had achieved an apex.

The vestal crawls into the hive. Many thousands of bees are living in closest community in this artificial house. If man did not give them this house, they would have to make a hollow tree, or something like it, answer the purpose. But man has been consistently giving them a house for thousands of years. What impels the bees to occupy this artificial house is just as consistently their own business, for only conditionally can you call the bee a "domesticated animal."

In a certain sense man actually "made" the dog which faithfully serves him, and whose intelligence appears to be awake to all possible human purposes. He has tended the bee, but has never been able to influence it inwardly. Everything that is reported about genuine bee "taming," and about their affection for the "bee daddy" is pure fiction. In its mad fairy tale of love and its attempt at organizing a state, the bee offers man a stubborn tradition which is old as the hills, looking down upon the few thousands of years of human civilization as upon a tiny mote of time. Man is planetary youth and still very green. The bee is planetary age. Flowering plants which require the visits of insects for fertilization have existed since the chalk age (which first saw duckbills and marsupials, but no monkeys nor men). There may have been bees and the beginnings of bee-states as long ago as that. It is certain that genuine social bees, directly related to our honey-bees, lived in the first half of the Tertiary, a few million years before our chronology begins. What are human states compared to that—the few thousand years that

razed Babylon, plunged Persepolis and Palmyra into the desert waste, and turned Athens and Rome into archæological museums?

Our little vestal goes to her hive. There is a humming all around her, in and out and up and down the chambers and corridors. It is a tight little citadel, piled up in truly alarming fashion, like old Troy that was dug out by Schliemann, with chamber next to chamber, cell on cell, and crammed food closets, where toothsome bread, carefully stamped together out of delicious flower pollen, is stored, or where the golden honey nectar flows up to the ceiling in swelling, perfumed plethora; and nurseries, where the hungry little worms stir or sleep in white silken cradles. Children! Where do children come from?

You see nothing but vestals everywhere you go, up and down, at the cell doors, in the depths, and flying in and out at the big castle gate. You count thousands and thousands of them. A normal hive contains between twenty and thirty thousand. And you note that despite their stunted sex they possess one thing which is not stunted —their maternal feeling. With touching solicitude the bees which do not fly out tend and feed the countless young in the hive's nurseeries from the collected stores, until they crawl out of their cradles as finished little bees. The method of feeding strikes us as somewhat strange. No "cooking" is done in the bee household, only "predigesting." The bee-nurse first samples the raw food, actually swallows it, converts it into a pure nutritive extract which could be taken up immediately into her own blood, then brings it up again and in this form (cleaned and refined, as a bee would say) feeds it to her foster child.

But with all this love lavished on them these youngsters too turn out to be vestals, sexually stunted females. They replace the gaps which death rapidly makes in the ranks. They mature rapidly, and tend the next generation of children which has meanwhile come into existence, and fly out and bring back supplies. But still the old question persists, whence comes this new blessing of children?

Quite obviously, the stork works without the active aid of the vestal bees. In summer-time, six weeks at most is their normal span of life; but in those six weeks they experience a production of children which continually functions in the hive and immediately replaces every case of death. The answer is not that all or part of the vestals just before the end of their life or at any other period of their six weeks' existence suddenly recover their sex. There's not a ghost of a chance of that. They grow up in one of the nursery cells, are

tended by older vestals, go through their natural insect development as worm-like larva and spun chrysalis, appear after three weeks in the hive, work, engage in nursing other generations and die at their appointed time, born as vestals, used up by life as vestals, snatched away by death as vestals. No doubt exists that, nursemaids of the highest order and by inherent profession though they are, they have absolutely no connection with the actual production of children, which remains a mystery in the dark background.

You study and study the matter, and finally your keen penetration discovers the following.

Your attention is attracted by a small group of bees which differ somewhat in appearance and size from the masses. There are six hundred to one thousand of them at the most, compared with the many thousands of the others. They do not fly out nor do they work; and they let themselves be fed on pap just like the young ones, and all this despite the fact that they are fully grown, and particularly big and strong—a curious crew of loafers in a giant household which sweats and pants with work.

You pluck out one of these idlers and examine him—for it is really a male, a so-called "drone," entirely normal throughout, with all the appurtenances of manhood. This obviously is a step in the right direction. To twenty thousand or more vestals we at least have a few hundred sexually potent males now. We have males; but these males and the vestals cannot do anything with one another! Are we to imagine the monstrous case of males without females hatching out young all by themselves? That is preposterous, and you see no indication of anything of the kind, either. These lazy drones literally do nothing. They neither seek copulation, nor do they care a straw about the development or whereabouts of the young; they loaf in the fullest sense of the word.

But one day your industrious search is rewarded by a new find. You observe a bee which hardly differs from an ordinary vestal, except that it seems a bit longer, approaching an empty nursery cell. Something out of the ordinary appears to be the matter with her. Other bees stand by zealously and stroke and fondle and feed her. And suddenly your suspicious-looking bee squeezes the hind part of her body into the cell and lays a pretty, small milk-white egg.

You have discovered the mysterious being called the "queen-bee." In view of the fresh laid egg, however, you understand what it really

is; it is the bee female. "The" female. In vain you ransack the whole hive for a second of her kind.

One genuine female to twenty thousand or more vestals and some six hundred genuine males!

All the progeny you saw sprouting in the hive, all the reserves of young vestals, came exclusively from this one non-vestal, this one genuine "wife," this one and only genuine mother. While the poor, sterile little virgins have been coming and going around her by the thousands and tens of thousands, like leaves on a tree, she has been sitting there since spring, full of vitality and teeming with the strength of her womanhood, always the same, perpetually laying eggs, and more eggs, an unlimited number of eggs, a thousand, two thousand, twenty thousand, fifty thousand, sixty thousand eggs and more in one spring and summer. She can lay as many as three thousand in twenty-four hours at one sitting. With a production like the sands of the sea, she naturally cannot look after the young herself. Generation after generation, the vestals do that for her with touching solicitude. All she has to do is to lay her eggs and let herself be fed, so that her strength may not fail her; everything else takes care of itself automatically.

Laying eggs is strenuous work, and the queen no doubt requires hearty nourishment in her permanent lying-in chamber. But you will recall that the word "eating" has another quite special meaning in love. In order that a new being may come into existence, every female egg requires a very special kind of food, namely, a male sperm-cell. You have seen this to be the rule so far at least. And only one thing can procure this mysterious meal, namely copulation.

You discovered those few hundred males in the realm for this purpose. Hundreds ought to be enough for one lone female. Involuntarily your vivid imagination pictures this vast temple of Vesta with its twenty thousand old maids and young virgins having in one corner at least a separate little sanctum of Aphrodite's, where love is zealously honoured in consonance with such colossal creative power. But you can look for that until you are blind. Not one of the lazy males stirs. And the queen, who in her active and useful way is a model of industry, as are all the other working members of the hive, seems to concern herself just as little about this lazy club corner in the industrious community. What are we going to do about it now? Is there no bridge here, either?

You ponder and observe once more. And now you will need years of study, but again you come upon something new.

At first you control the solitary-hopeful activities of the queen. You place a fresh-laid egg under the microscope and look at the egg-cell. Her Royal Highness' ovary produced that without any outside help. But you also see spermatozoa! Undoubtedly the egg was literally covered with male semen at the moment when it was laid. But where did the semen come from?

Cut a queen-bee's body open, and you have the answer. There is a big, fat "semen pocket" full of male semen on the oviduct. Recall the vineyard snails and the spiders, and how in their case the semen did not get to the egg-cells simply through the agency of copulation, but a special pocket in the body was filled with a reserve stock of semen which was discharged over the mature eggs afterwards, at leisure and as required. The solution dawns on you. Though our queen lays more than sixty thousand eggs in a year, she need only have had sexual intercourse once, at the very beginning, when her semen reservoir was filled up. From then on she is double-sexed in an ideal sense, for since the little strangers, the spermatozoa, once received, continue to live on in their secret drawer in *dulce infinitum,* she has at all times enough "male element" on hand to "fertilize" all of her sixty thousand eggs, piece by piece, as they mature and press forward in the course of time, and she can do this herself, without further male assistance; in other words, she can supply her eggs with the necessary "character fodder" in the sense of our old dwarf story.

And that is exactly what does happen. In the spring of the year came a day, when Miss Queen left the castle. "When all buds burst," she frolicked in the breeze, and at this same time the lazy drones, here and in the neighbourhood, had just flown out. And these drones consorted with her. She too had been a vestal until this nuptial hour, but only from lack of opportunity, not, like those thousands of poor things in the realm, because of the annihilating decree of physical impotence.

When Mrs. Queen returned from her wild flight, she was forever Mrs. But at the same time she never needed a male again. Once for all time! Her semen pocket, which was filled to the brim, afforded fertilizing material for eggs without number. The male semen continues to live on for quite a while in the human female too; for

several weeks, it is alleged. In the case of the hen, it lasts for a certainty over two weeks, and several months among the bats. Simply imagine this to be extended over years, and you have the situation of the queen-bee, which experiences sexual union "once and forever."

Literally years. For with this one summer, about which I have been talking, the life of this wonder thing called "queen-bee," is by no means exhausted. She has loved. Her semen pocket is filled. She has laid eggs. The vestals which were about her before the act of love took place, suckled the first generation of children, and then fell gradual prey to the six weeks' limit of their poor toilsome vestals' existence. Vesta's first generation passed on. The new generation remained. But Aphrodite remained as well. And, incidentally, so did the drones. Egg laying continues. One whole summer has been spent in egg production by the inexhaustible proud strength of the one queen-bee's motherhood, in the unselfish care of the young by the thousands and tens of thousands of poor, dear, short-lived little old maids, and in Homeric lounging and loafing on the part of the male drones. What next?

I think that during this whole narrative your mind reverted to another question, the initial question. The thousands of new vestals which continuously bob up are the offspring of the one consistently female-sexed bee in the hive, the queen. We understand that. The drones supplied the queen with the male semen for her colossal mass production. That is fine; that is clear too, even though it happened somewhat summarily. But now a logical new question troubles our conscience. Where do the drones come from, whose existence in the spring was simply predicated as a prerequisite? And, finally, where did the first generation of vestals come from? For no doubt you understand that such a generation had to be on hand before the queen-bee's egg laying activities could successfully begin. When the first batch of eggs was laid, a generation of vestals must have fed the first instalment of helpless little worms which crawl out, otherwise the whole pretty machinery of the hive would never have been got going at all.

In order to solve these three new questions, we really ought to trace things backwards, but in this wonder world it makes no difference if we simply keep on marching ahead. The serpent bites its tail again, as the year, coming from spring through summer, fall and winter, runs into spring again.

On with the text, therefore; straight ahead. Toward fall a summary clean-up procedure takes place in the beehive with regard to the extant remnant of the superfluous drones which apparently had been tolerated until now for some purpose or other. In view of the gradually increasing general shortage of provisions, they are no longer fed and in the end they are simply treated rough, stabbed to death or thrown out of doors, doomed to certain destruction. The bee-master calls this spectacle the slaughter of the drones.

Winter ensues in dead earnest after this Massacre of St. Bartholomew for reasons of frugality. The protection of the hive and their own crowded proximity keep the survivors from dying of cold, and the collected stores from death by starvation. The production of young naturally ceases entirely. The queen and a last autumn generation of vestals which stubbornly cling to life and seem no longer bound to the six weeks' span of life, come through safely and experience a new spring. What next? The really strangest thing of all happens now.

Sun and flowers are here. The vestals which survived the winter swarm out and bring home fresh food from the newly opened market. And the queen resumes her egg production. Like Fortunatus' purse, pregnant with gold, the old semen pocket of this mighty mother continues to be inexhaustible. From it she continues to throw the necessary note of manhood on each egg, the living manhood of the old, long forgotten and buried male drones of the year before, spermatozoa which have survived the act of love by almost a whole year, and the last of the drones by more than half a year. . . . ! New vestals grow up. Everything seems to begin at the beginning again according to regulation. Then all at once something brand new takes place.

The vestals, which not only fetch bread and nectar but are also incessantly engaged as clever builders in repairing and new construction work, have quietly prepared a number of nurseries which are bigger than the usual ones. And in furnishing these with the necessary living contents, the faithful queen-mother too does something quite revolutionary and new.

She lays an egg in each of the giant cells; but put the egg under the microscope, and you will note that this time she has omitted something that otherwise is absolutely essential. The egg did not receive its necessary shot of semen! Obviously the free mistress of her semen pocket, she has simply kept it closed on principle this

time. Unfertilized eggs! That is nonsense. The big nursery cells are to remain empty with malice aforethought, you think.

But what do you see! The vestals pile up sweet pap around this unfertilized little egg and they quite unambiguously expect developments for all that. And right they are; for the little worm emerges, is fed on pap, turns into a chrysalis and on the twenty-fourth day walks out of the nursery as a fat drone.

Riddle of riddles. The queen has free control over the fertilization of her eggs. If she does not want to (*i.e.*, if a certain definite instinct of hers protests), she does not fertilize certain eggs in particularly large nurseries of the hive, and out of these unfertilized eggs every time, according to iron law, come genuine sexually potent drones, males instead of stunted vestal virgins. Forget the entire bee-state for a moment and take to heart just this one curious fact.

The scientist calls this occurrence parthenogenesis, from "parthenos," the Greek for "virgin," and "genesis," meaning "origin" or "generation"—virgin generation. This does not mean the generation of virgins, but a virgin having children. The term is a very poor one, particularly when applied to this case. For obviously our Mrs. Queen-Bee has not been a virgin for a long time, having laid many thousands of regularly fertilized eggs in one year alone and still carrying in her body a gigantic box full of semen savings from her last year's sexual union, sufficient to bestow the free male heritage on a million more eggs. In this case almost the exact opposite is true: namely that the eggs from which drones develop are virgin eggs, which no male semen has touched.

This latter fact is quite enough to constitute a miracle.

Here is one of those cases which undoubtedly make the scientist feel like breaking out in the old paradoxical cry of desperation: "I have seen it, but I do not believe it." The fact itself can no longer be doubted to-day; the most hair-splitting observers have tried their hand at it again and again. Moreover, the occurrence of a number of related cases among other arthropods has been proved, which merely relegates the case of the drones to its proper order in a certain, more general line.

Theoretically, we apparently have here a most serious exception to what is otherwise the "iron law of sexual reproduction" throughout the whole animal and plant world; an exception to the rule that the regular mingling of a male sperm-cell with the egg-cell is a natural step in an act of procreation proceeding from a regulation

sexual organ (a female ovary) and a specifically female cell. We discussed the fact that in addition to sexual reproduction, the original form of simple cell-division for a long time persisted far into the ranks of many-celled beings, as in the case of the hydra and even the starfish. But simple cell-division is not involved here; the point in question is that an unfertilized egg, not stimulated by any artificial means either, proceeds to generate a new being exactly as if it had been fertilized.

A topsyturvy world once more! It comes hard to dig into it. Fortunately, that whole tremendously involved matter of the chromosomes being reduced by one-half for the act of procreation, for the purpose of crossing two individualities, is eliminated here. In individual cases of arthropods laying virgin eggs (they are found among all manner of lice, wasps and crayfish, in addition to the honey-bee) it has been directly shown that the virgin egg does not divide its chromosomes in half, but keeps the full number, consonant with the situation that in its case no partner is contributing a half. Among our bees (if the microscopic observations are entirely correct) the chromosomes in the egg from which a drone develops are halved at first and the half which normally would be superfluous is thrust out; in other words, this egg momentarily matures in the expectation of semen entering; but when no sperm-cell comes along with its contribution of chromosomes, it is supposed that the remaining half of the chromosomes in the egg supplements itself by doubling so that the generation of the drone can proceed even without semen, and for that very reason with a full quota of chromosomes. All this is strange enough!

Let me attempt a little auxiliary construction which will shed as much light on the salient points of this occurrence as is possible; because there are no real explanations for it as yet.

You will recall that the hydra frequently had offspring which grew directly out of its body in plant fashion, like twigs or little shoots, entirely regardless of the animal's male or female sexual organs. Then in the case of the medusa and, still better, in the case of the tapeworm, you saw how this form of reproduction by budding came to take place in alternation with sexual reproduction. You saw animals where male and female reproduced regularly with spermatozoon and egg; but then from the offspring originating in this way a second and occasionally a third grew by budding, like the shoot of a plant. And only the third or fourth generation returned

to the principle of "man and wife" and reproduced sexually again. This, of course, does not apply offhand to the parthenogenesis of the bee.

The young drones do not by any means originate by budding anywhere in or on the queen-bee; they developed along one-half of the road of genuine sexual reproduction. But having gone half-way, they turn their back on sexual reproduction by developing into finished animals without going the other half of the way, in other words, without male semen. Although the two cases are certainly not identical, perhaps you can learn something from a certain analogy.

In the case of the hydra polyp you had sexual reproduction and reproduction by budding taking place side by side in the same animal. In the case of the tapeworm this "side by side" was stretched out into a temporal "one after the other." In the case of the same animal, individuals reproducing sexually and by budding followed in regular succession. Simply leave aside the difference between "sexually" and "budding," and merely keep in mind the "side by side" and "one after the other."

Take any insect you please. At first it reproduces quite regularly in the sense of the great achievement in our old story about the dwarfs; that is to say, purely sexually. Male seeks female, between them they bring a sperm-cell and an egg-cell together and out of their fusion, in the course of which sperm-cell and egg have "eaten" each other up as it were, a new young insect develops. This new insect (recall the story about the dwarfs) in turn is either a male or a female. It so happens that the old pair of insects produce sexual young, and among these you find males and females side by side. Why a male develops out of one egg and a female out of another (right on up to human beings) remains a mystery to us, but does not touch our train of ideas directly.

Merely imagine now, that this "side by side" in this strictly sexual case were transformed into "one after the other" by some strange complication of circumstances, as follows. The two parent insects procreate sexually in the regular way, but the product is not a brood of young, of which some are males and others females. Instead, as in the case of the tapeworm, a succession of generations, separated in point of time, results: say first, a female, which, however, possesses the ability, after a certain length of time, to bring forth a male of its own accord without fertilization. Only after

the birth of this male would fertilization be absolutely necessary, in order to start the chain again.

Since we want to have nothing to do with budding, and a direct transformation of a female into a male within the same individual is not supposed to take place either, there would seem to be no explanation left for this curious sequence of life but an apparent dissipation of reproduction over three generations in partly genuine, partly half-way and faulty sexual generation. First you have the old, genuinely sexual pair, and from this, a single female, procreated directly and entirely sexually, as offspring. Then this female, by means of an egg alone ("half-way" sexual reproduction, therefore) generates a male. The chain would now be bound to come to an end with this half-sexually generated male if it did not for its part mingle entirely sexually with an alien female, so that thereby the whole succession of generations could begin again from the beginning.

You comprehend this chain theoretically at least, do you not? Of course there is room for complications; something fairly obvious for example. Suppose the first female offspring, which has the power to continue generating one or more males from eggs alone, without the act of fertilization, were, in addition, to proceed to regular procreation with some available male! With this male it could then start a new independent chain of which it would be the first link, lying outside of its own sequence of generations: that is to say, with this male, the female would again generate females which as such (as links in this new chain) would again be able to produce males independently and without fertilization. That would result in the following main chain: sexual generation between male and female; a female as the result; this female can optionally generate males without fertilization, by half-sexual generation (merely with eggs); but in addition it can generate new females, just as its parents did, by all-sexual reproduction (with fertilized eggs), by fresh sexual intercourse with a male; the males generated by it in the first way in any event require females with which to reproduce in the regular manner and therewith they return to the state of the grandparents at the beginning of their chain; on the other hand, the females generated by it in the second way start a new chain and proceed to reproduce just like it in both ways.

It makes your head swim for a moment; and a hard nut to crack it is. But keep your feet on the ground: for this is identically the

case of our queen-bee. Stop to think about it! Our queen-bee very obviously had the gift peculiar to this second generation stage.

The queen-bee is a female, which of its own accord, as a link in the chain and without new copulation, can procreate a third generation half-sexually (with unfertilized eggs), and a male one at that: to wit, drones.

That is to say, the queen-bee is a female which can do so; but it can also mate with a male. You saw how our queen at the very beginning of her career did so right merrily with the male drones available at the time. And then the queen-bee quite logically lays eggs which are fertilized, and females emerge from these eggs. In our special case these are poor sexually crippled females, the thousands and tens of thousands of vestals. But that is another matter, and we shall discuss the special reason for it later on. In any event, there are females here as well, and all the assumptions about the second or middle generation are therefore fulfilled.

The only question remaining is this. Is the queen-bee the product of genuine complete sexual procreation between male and female? And do the males which were generated "parthogenetically" by the queen-bee—the second year's spring drones—for their part indulge in regular sexual intercourse with females, so that the chain begins anew as a result? If so, we should luckily be right back where we left the main thread of our discussion, and I need only go on with the story for you to see that the case of the bee is absolutely identical with our theoretical case on these two points as well.

Let us clarify this at once. Up to now our queen actually generated only vestals from her fertilized eggs, vestals which were females, to be sure, but were not really capable as such. After the drones too have been generated (from unfertilized eggs) a third thing happens as the crown of all the queen's activities. The queen-bee also procreates sexually capable females, as follows:

Hardly have the nursery cells for the drones been built and occupied, when the building vestals' sudden mania for innovations finds expression in an even stranger work. They built bottle-shaped cells which are even bigger and more substantially constructed, but only a few this time. These are destined to be the most important ones in the hive. Nothing less is to grow up in them than new queens; at least one, though possibly more.

The royal cells, real nurseries for royal children, are soon finished. The only question now is, where the eggs which are to hatch

out queens are coming from. The old queen has so far done her job so faithfully and procreated and laid everything that was to be procreated and laid, that she will no doubt know how to turn this last trick. Involuntarily you ponder the question, "how"? A new future queen must be a female; am I not right? An unfertilized egg is therefore entirely out of the question, since that would produce a male, a drone. But will a fertilized egg answer the purpose? So far, every fertilized egg (as so many thousands proved to you) produced a "female," but only a defective one, with stunted ovaries and useless sexual parts; in other words, a vestal. Is it possible that the queen carries an extra special brand of eggs in stock, which will solve this dilemma?

This speculation proves in vain. She has no "third bag of tricks" on which she can draw. But something new, something which externally does amount to a "third bag of tricks," comes from an unexpected quarter.

She lays a plain, ordinary egg in the royal nursery cell, exactly as if a vestal were to hatch out. It gets its shot of semen out of Fortunatus' immortal money-bag; and with this, the queen has done her duty as a mother. And now the nurse-maid vestals of the hive come into the foreground again. They had constructed a different sort of cradle for this exalted child, and now they consistently carry on by feeding the favoured infant differently, with more and better food from the very beginning.

The result of this feeding process is the development of a genuine, sexually capable female. . . .

Instead of a vestal, a genuine new queen-bee originates in the royal cell; that is to say, a female bee with ovaries which are not stunted, a sheath capable of copulation and a normal semen pocket. This fact, as you comprehend, is of the most far-reaching importance for judging the whole miracle of the bee family. The riddle propounded above, why vestals and not sexually mature females came out of fertilized eggs, is solved at once.

Every one of the queen-bee's fertilized eggs had and has the inherent makings of a genuine, normal female. According to the way it is fed in earliest infancy, the female either is stunted at an early stage and becomes a vestal, or matures and becomes a queen.

In other words, strictly speaking the vestal is an artificial product, made so by insufficient and faulty nutrition. During the entire preceding period, the vestals of the swarm, in their character as

nurse-maids, invariably and intentionally let only vestals develop. And now for the first time they have just as deliberately departed from this principle, and have let a little one grow up to be a queen apparently by feeding it "better," which obviously means by feeding it normally for the first time.

The fact of the matter is absolutely certain, and is further confirmed by an unambiguous fact. Assume the hive loses its queen through sudden death in the spring, before the royal cradles have been built and occupied. In that case, a young mite, which is already destined to be a vestal, is simply suckled on luxurious fare and becomes a queen-bee, in which connection, its simple cell is rebuilt into a royal cell. Assume the queen dies and there does not happen to be a single young vestal larva which can be "fed" to be a queen in the whole hive. In that case, the general plethora of rich food stimulates the mature vestals to a championship performance. They react to the rich fare like a human being put on a training diet of raw eggs, chopped raw meat, red pepper and Tokay wine. Their stunted ovaries are finally forced to a limited production of eggs after all, and being unfertilized eggs, only drones hatch out. This exception to the rule throws sufficient light on the vestal's "artificial" character, which a change of diet can cause to disappear to a certain degree even when the vestals are mature.

You see now that the real bee story coincides completely with the imaginary case we assumed above. There is a genuine act of copulation between male and female, drone and queen, in the beginning, but the resulting generation does not consist of males and females side by side. Instead, there are two generations with the sexes alternating, one after the other—a female queen-bee, which can generate male drones—of her own accord without fresh fertilization.

There is a simple complication of no basic importance in the fact that this same queen, before she procreated males by parthenogenesis or "virgin generation," let herself be "mated" and procreated females as a result.

Looked at in this way, the amazing "virgin act" of generating drones loses something of its paradoxical and revolutionary character. The principle of fertilization with its old reliable prescription of sperm-cell and egg-cell does not appear to be overturned thereby; and you see how necessary it is in order to start the whole machinery. In this case, the principle appears to be merely somewhat elastically stretched out with a sort of periodic pause in the decisive piston

thrust, during which the machine, powerfully propelled as it still is, runs on a piece further, as if under the spell of the law of inertia. But let me go on with the bee's fairy-tale.

Spring is somewhat advanced, and you now have in the hive: firstly, the old queen-bee, which was mated last year, but continued active and capable of procreation; secondly, a huge tribe of vestals, constantly increasing; thirdly, a small stock of new-born drones; and lastly, a new queen now eating her way to queenhood in at least one of the "royal cradles," and there may be several. What next? The logical thing would be extremely simple.

The new little queen would emerge full-grown one day. She would make friends with drones and take over all further work of generating vestals throughout the summer, and new drones and a new queen the following spring. And the old queen-mother, who had done her work of procreation so many thousands of times during an entire year, would shut up shop and quietly disappear from this earthly stage, following the many generations of vestals whom she had survived.

But you are counting your chickens before they are hatched. You are tremendously underrating two things: first, the stubborn vitality of this same queen-mother; and, secondly, the no less inexhaustible vitality of those spermatozoa surviving from last year within the queen-mother, rejoicing in a continued existence of their own, which seems to guarantee the procreation of countless more vestals and queens. This first part of your logical syllogism actually does take place, but it is bound to go mighty violently and in a somewhat revolutionary form in view of the queen-mother's high-spirited "carrying on."

Two queens in the state, in full procreative activity, will never do. The number of vestals would soon grow to monstrous proportions, and in every way an embarrassment of riches in matters pertaining to motherhood would result, which would destroy all order and discipline. The hive is overcrowded as it is, thanks to the cumulative springtime achievements of the old queen. What's to be done? A partition must take place, that is all; a partition of the entire personnel into two stocks, of which only one can remain on the spot, while the other must emigrate! Each stock or tribe will naturally have a queen; this one the old queen and that one the new. Just as during hard times the old Italic tribes used to give an entire generation of adolescent youths and maidens into the hands of the

gods as a "spring consecration" (*ver sacrum*), by simply compelling them to emigrate, one of the two swarms must go out into the uncertainty of exile, to seek a new home, as a spring consecration. The only difference is that according to the old established custom in this bee-world, which is organized on such eminently practical lines, the mature, older generation condescends to do the emigrating, and not the young one.

About eight days after the queen-mother has laid the egg, the happy, gorging larva time of the first young queen in her royal cradle comes to an end. All wrapped up as a chrysalis in a resting cell, she prepares during an equal length of time for her mature resurrection in consummate glory. Her entrance into this last quiet ripening stage gives the old queen the cue for her part in the show. She gathers around her a tribe of from ten to fifteen thousand vestals, and many more if the population of the hive is very large, and then they are off. The advance guard, the first or virgin swarm, leaves the hive and "swarms," as the bee-master says. It lets itself be caught easily by the bee-master and locked up in a new house, the interior of which it immediately proceeds to finish and populate anew, the birth rate rapidly bringing the population up to full strength.

Meanwhile, everything runs along straight as a string in the old house. After the half of the old populace which remained behind has worried along for another eight days with no queen in sight, a high clear "toot, toot!" suddenly resounds out of the closed shrine of the young nascent queen. It is the signal that the chrysalis stage is over, and that the ripe new queen has arisen in the fulness of her strength. Assuming that only one sovereign cell is occupied, this single new one steps out and opens the young era without opposition. She will fly out and copulate with drones. The possibility of inbreeding might disquiet you for a moment in this connection, since according to the *modus operandi* the drones flying along on the nuptial day would all necessarily stand to the queen in the relation of brothers to sister; but the drones change over quite freely from hive to hive. And besides, since the nuptial flight invariably takes place at a time when the drones of all the hives round about are taking their daily constitutional flights, there would seem to be plenty of elbow-room for the queen-bee to cross with strangers. By virtue of this, the young queen will generate thousands and tens of thousands of female bees throughout this her first summer sea-

son, and these will invariably become vestals and nothing more, as a result of deliberate malnutrition.

On the other hand, if at the moment of that tooting, a second young queen similarly reports as "among those present," another "*ver sacrum*" immediately becomes necessary. Instead of entering upon her reign in the hive, the first-born young queen gathers a part of the old stock around her, as did the old one, and goes with it into exile as the second or later swarm, out into the world in search of a new home.

Much more remarkable than these things are the simultaneous doings in that first mother colony with the old queen at its head. There first does the one hundred per cent efficiency of this worthy old dame come to light in full glory. She is now entering upon her second summer, but she continues to lay eggs enthusiastically, thousands and tens of thousands of them; and all summer long she fertilizes these thousands of eggs from the old pocket full of semen, which is now a year and a half old.

Never again does a male bee touch this chaste widow. And yet from that one ancient springtime love affair she still has semen enough in the pocket for every egg to produce a vestal. And again winter comes; again she hibernates with the last remnant of vestals which hang on to life the hardest. And again in the spring of the year (the third of her life) that parthenogenetic force within her, "virgin generation," a principle, which was implanted in her by her parents when she was procreated, is still sufficient for generating drones from unfertilized eggs, while her semen pocket still suffices to bring forth one or more genuine queens from fertilized eggs on the side. And the result of this is another exodus, another "spring consecration" with the venerable queen at the head of a troop of exiled vestals for a second time.

All this is repeated for the third time, throughout a third year. The strength of this female patriarch visibly lessens somewhat. She does not lay as many thousands of eggs as the first year; but lay she does, immutable of purpose. The third year passes; and the cycle may start for the fourth time. Think of it! You have before you an insect individual which in comparison with the majority of its race, the summer vestals which live only six weeks and often much less, has already attained an age corresponding to that of a human being who would live to be twenty-six times an average age of thirty years—a patriarchal age of almost eight hundred years.

Two things live in this individual throughout its gigantic span of life: firstly, the power transmitted directly by the parents in the course of copulation, of producing new bees, and invariably males (drones), of its own accord, by pure "virgin generation"; and secondly, there lives on in this individual, from the one and only own copulation in the first spring, the power of procreating bees from fertilized eggs and in this case always female bees, vestals and queens, by virtue of that one and only time at which the queen-bee had intercourse with males.

For the latter thing to be possible, the semen from a generation of drones, which the queen-bee found existing at her birth, must continue alive and unchanged for several years in her semen pocket. This generation of drones had perished three years before, so that unchanged spermatozoa, not one iota further developed, have survived their "male," their original possessor, by three whole years. If we were to grant the father drone an effective span of life of even twelve weeks (this figure corresponds to the approximate total duration of a drone's existence, of one which did not live to copulate but ended as an old uncle in that slaughter of the drones) and compared this with the human span of life, say sixty years, spermatozoa, which at the end of the queen's third year had survived their original male owner by twelve times the latter's life span, would still be emerging. Relatively speaking, if the father died at the age of sixty, his semen would be living on after nearly eight hundred years, surviving the father by more than seven hundred years, and that not as "semen" or "seed" in the biblical sense, which symbolically means the continuing generations of children, but in the literal sense of the word. We here have one of the greatest wonders of reproductive life which is so infinitely rich in wonders. . . .

The fairy tale about the bees is nearing its end with this last miracle. These patriarchal queens sometimes live and generate into a fifth year, which makes all figures go up again. But then (and mostly before then) this inexhaustible magic fountain of life reaches the end after all, the semen pocket is empty and the force of virgin generation dies, and her own vital force finally fails. . . . Finis.

Let us philosophize a little about the bee state.

There is a dangerous source of misunderstandings in the expression "state," particularly when you have become accustomed to speaking about a "queen." The imaginary picture of a monarchical state after human fashion, with a queen reigning at the head, the

drones a kind of indolent aristocracy and the great mass of the population, however, more or less suppressed working proletariat. That sounds all very pretty; the massacre of the drones even seems like a regular revolution of a social class hemmed in to the bursting point, and you can draw still other analogies from the fairy-tale. But these far-fetched analogies are the very last things which will enable you to see into the heart of the matter and draw the really instructive conclusions from the bee state which could be applied to human circumstances.

Keep clearly in mind that the bee state, even if you choose to call it a "state" in the sense of a social association of many forming a united whole, is organized on a single principle, namely love—love in the sense of including all matters having to do with reproduction, however remote.

It is a "love state" in the most daring sense of the word.

Of course there is no real tyranny whatsoever, with an absolute monarch, a real reigning queen. The word "queen" gives a very inexact picture. And just as little are the drones a ruling, exploiting, idling upper caste; or the "female workers" exploited proletarians.

The supposed "queen" is nothing more nor less than simply the "woman" of the state. *The* woman!

The supposed drone aristocrats are the "men" of the state. *The* men!

The supposed workers are the "nurse-maids" of the state, the foster-parents, on whom devolves the exclusive care of the young generation; they have merely taken over caring for the real parents (the drones and the queen) as an appendage to the care of the children, so that actually the entire work of the hive, with the single exception of copulating and laying eggs, does rest on their shoulders.

A woman, men, nurses and children—you see that the fundamental elements of this state are merely the most essential parts of the concept "family." In its innermost structure this whole gigantic lump of many thousands of socially united animals forms nothing else but one huge family.

The details are in the highest degree singular. They show you the bee as an utterly mad, individualistic experimenter as regards the great thing which is concealed behind the words "love, marriage, family"; a fantastically daring innovator, but not really a happy one.

In order to solve this riddle, it will be necessary to fix on the certain starting-point of this experimenting. Recall the spider therefore. The spider is an arthropod, ranking considerably lower than the bee, but somehow or other connected with the bee's ancestors even though not in a direct line. In the case of the spider, you find "husband, wife and child," but no special "nurses." Male and female come together occasionally for the act of copulation, but after the act, the male withdraws without bothering himself further about the consequences. The female, however, cares for the welfare of the young to the best of her ability, at least to the extent of building a secure nest for the eggs and guarding it faithfully to the autumnal end of her own life. The child-nurse is "ideally" there; she merely coincides with the wife, with the mother.

In the inherently similar case of the stickleback, we saw that the father can at times assume the duties of caring for the offspring, and I intimated what might be deduced from this for marriage in the higher sense. Let us follow the road running via the spider and see what the bee made out of this principle.

The bee quite obviously proceeded from the principle practised by the spider as from an original programme. The drone, the bee-husband, does not bother itself at all about the care of the children. There is no question of stickleback circumstances, prevailing among the bees, to say nothing of a higher stage, at which both parents devote themselves to the care of the offspring. The care of the children is exclusively in female hands among the bees; for the vestal originally was a "female," though now a stunted one. But the extremely curious thing is that the vestal tends the queen's children and not her own. You simply have two kinds of females here.

The one female, the queen, is mother only in the sense that she copulates and lays eggs. The other female, the vestal, is mother merely in the sense of caring for the eggs laid by the other female, and for the young. What the spider female united in herself, loving and child-bearing wife and mother looking after her children, appears in the bee torn apart in two persons, a "loving and child-bearing wife," the "queen," and a "foster-mother," the vestal.

This simple fact is obviously the logical key to the whole bee state. In the case of the spider you have two persons with a certain division of labour in the matter of love; the male with semen and the female with eggs. Then mother-love developed as extra work

piled on the female alone. In the case of the bee you have that first division of labour persisting in drones and queen. But then you have a further division of labour on the female side; the female's extra work as caretaker of her children is saddled on a sort of secondary or subordinate female, whose heart and soul are in this work. The type of the unwedded vestal, never laying eggs herself (not as a regular thing, at least) but sacrificing herself to the last ounce of her strength in the care of another's brood, makes its appearance.

This was the decisive achievement in the bee state. Two questions immediately and urgently arise: in the first place, how could anything like that come about and in the second place, was it really very useful and progressive?

The first question can be answered at once by recalling how vestals still originate. Every vestal is a genuine female according to nature's essential designs, only in its sexual parts are stunted. This is not an inherent organic defect, but is the result of malnutrition. That affords a very deep historical insight into things. From this point, scientists have been able to reconstruct the entire historical development of our bee state of to-day in its most probable stages with marvellous clarity, and Buttel-Reepen in Bremen has latterly brought this to a climax of comprehensive completeness. I shall merely pick out the main line of his argument, in so far as we need it.

Once upon a time there was a primitive bee. It had the faculty, not particularly strange in insects, of laying huge masses of eggs on the strength of one act of copulation and, in addition, thanks to the special, singular gift of virgin generation inherent in the insect race, even without copulation; eggs from which females developed in the former case, and eggs from which only males developed in the latter case. The larvæ crawling out of these eggs required a certain amount of good food and care. The old bee possessed plenty of maternal feeling, and dragged in food for all she was worth.

But her procreative power far exceeded her strength as nurse and provider. Friend husband would not help out. What was to be done about it? Despite her utmost endeavour, she was unable to fill all the hungry little mouths. After a while the first instalment of young little bees crawled out. But how terrible! Insufficient feeding had stunted them. Their sexual parts had become unsuited for reproduction. They seemed forever shut out from wedded love

of their own. There they sat—poor little virgins. What was to be done with them? They saw the old mother, who still had a huge raft of children in swaddling clothes, wearing herself down to skin and bone trying to look after them. Barren of all longings for love of their own, these little virgins pitched in and helped the old woman. They fetched food. Their inherited maternal feelings were awakened, even though the children which they fed were not their own. They lightened the old mother's burden, helped out everywhere, and finally they managed feeding matters so that, in addition to the many stunted ones, a few unstunted, sexually capable bees, males as well as females, reached maturity, assuring the continuance of the species.

From here to our perfect "bee state" is certainly a long step, but I believe you see how in the long run it could develop in some such way. At least you have a shrewd suspicion that no special magic was originally required to make possible the two kinds of females, procreating queen and merely ministering vestals.

The interesting thing is that this is not pure fiction. Among the bumble-bees, relatives of the bee which live together in large families but not even approximately in such gigantic states as the bees do, you still find certain stages of this process of development "petrified alive," as the normal condition to-day. You see a fully developed, genuine bumble-bee female, comparable to the queen-bee, which copulated with a male in the fall, and then hibernated alone. In the spring it lays its first instalment of eggs; larvæ are produced, and the old woman, impelled by her maternal instinct, feeds them as best she can, which naturally is insufficient, in view of their large number. Small as they are, and far from all drones at this time of the year, these first-born females never come to reproduction; but their maternal instincts report for duty, they immediately pitch in and enthusiastically help out with the nursing of the larvæ, they relieve the old egg layer of the trouble of fetching food and, finally, toward late fall, they succeed in rearing regular big females out of later larvæ by special intensive feeding. These genuine females in turn find drones, which have meanwhile been brought into the world by both parties, by the old tribal mother in addition to her other egg-laying activities and occasionally by the stunted females per parthenogenesis. These genuine females copulate, hibernate and merrily start the whole story again from the beginning in the green springtime. I believe you see a bridge to the bees here.

Let the small number of bumble-bees swell to a giant mass. Let the egg-laying force of the original super-female, the regulation "queen," increase monstrously, the more she gets relieved from the burden of work. Let nurses, those at the head of the last column, likewise hibernate, in order that the queen, fertilized in the fall, may have help on hand when she lays her first eggs in the spring. Let this queen with so much help at her disposal find the strength to hibernate a second time and oftener. In return for this, she is to take over the virginal production of males entirely, so that the nurses normally become utter and complete, unfruitful vestals. Simultaneously let the organization of the whole be further developed and perfected, including the complicated food storage, nursery and feeding arrangements. All these stages can be more or less clearly studied "alive" among close relatives of our honey-bee to-day. And now let man offer good artificial shelter, and you have reached your goal.

It has also been possible to solve the riddles on the lower part of the genealogical tree below the bumble-bee right on down to the first stages where mother and offspring were brought together alive and where the care of the young could therefore begin at all. In the case of the spider, you saw the mother only as the guardian of the eggs; she is dead when the young crawl out. Certain older varieties of bees which live alone have no living ties to their offspring either. The old one lays an egg, shoves some food into the cell which she has previously built for the purpose, and then goes her way. At the next higher stage, the mother for the first time lives to see her young; she builds a row of protective cells and is still at work on the last of them when the first egg in the first cell is delivering a larva. The relation becomes a closer one when the old lady has acquired the habit of shooing away bad parasitic insects during her building operations, and continues this guardian service after all the cells are occupied by eggs and have been closed up. Nothing would be more obvious than for the mother in the latter case gradually to proceed to the feeding of the larvæ. If an inherited instinct gradually fixed the feeding of the young as an iron rule of life, the entire foundation would be given, on which a sort of premature development and anticipation of this maternal instinct by the vestals could build up the history of the higher bees later on. No obstacle presents itself anywhere to the clear historical view.

Remains only the second question. This bee business is an in-

teresting case, I grant you. But the question now arises whether a principle of progress is really involved in it. Involuntarily you are seduced into believing that the bee state must mark a great step forward, because of the great social unity which obtrudes itself on your first view.

It is not a union according to the old principle of the siphonophorans. You will recall the jelly-fish which grew together and formed a sort of super-animal like the fabled "King of Rats." I did not go into the matter further and criticize this siphonophoran super-animal at the time. It was constructed on the principle of complete division of labour. Entire animal individuals become "organs"; some became stomachs with mouths, others swimming-bells and so on. Nothing of the kind became possible in the higher animal world. There must have been a good reason for that, and it is easy enough to see the reason. It lies in increasing individualization. The more fixed and determined the individuals became, the more difficult did this sort of social union, resulting from physically growing together, become; ultimately it became impossible. You just saw how the conflict swayed back and forth in the case of the spider's sexual life. Individualization broke through: "no permanent growing together; each individual for itself, and free" became the established principle. New and more highly organized social associations could in turn originate with these self-contained "free" individuals. But in a totally different, freer form. They did originate; think of simple marriage. But let us go further. We human beings are the best example in every respect, the example which shines to the stars. That was really a higher stage, not at all after siphonophoran fashion without any physical growing together. Even so it contained much oppression; we human beings are in a position to know this best in our social history. Much had to be corrected in that respect, and still must be to-day, unfortunately.

But let us go back to the bee. It most certainly did not revert to the siphonophoran state; it could not possibly do so. Bee individuals, growing together by the thousands simply would not have worked. But did the bee find the road leading toward that higher, freer social union with this "state" composed of so many thousands of individuals? One is compelled to answer: No. The bee state functions with many thousands of "individuals," and without any growing together in the siphonophoran sense. And yet a step backward is inherent in it.

The bee state started at the sexual angle, and herein lies the daring of it as well as the tragedy; at that point in all animal evolution, where marriage in the higher sense evolved. Much later, in the case of man, marriage was to become one of the most important problems along the line leading to the evolution of the state. But the bee began with the organization of the state at a stage in which the development of marriage was by no means clarified as yet. And that was its doom.

The bee state proceeded from the fixed and determined individualization of the male and the female, and it remained true to this principle. But it did not make the slightest start in the direction of deepening it. Copulation brings male and female together for a moment. That is the extent of "marriage"; exactly as in the case of the spider, barring only its eating instincts. Parental feelings are confined to the female side. The male, the drone, decisively retains a rôle of no consequence, participating only for a moment in the life of the race. Lazy and purposeless, it squanders its whole life, and its violent end is not much less wretched than that of the male spider which was eaten up by the larger female spider; this wretchedness has even become a sort of rule with the male bee. It marks no progress whatever, but rather a decline.

Now for the female. The female appears as a double individual: queen and vestal. If you look closer, however, you will see that each of these two individuals has suffered a heavy loss by this doubling process. The one, the queen, has totally lost her maternal feelings. Parental feelings, however, marked such a tremendous spiritual step forward. And she has lost her freedom in other ways; she needs outsiders to feed her. Conversely, the vestal has lost the noblest life of all, sexual life; she has passed out of the horizon of that higher association of "man and wife" entirely and for good; she knows the male only as a lazy guest whom one occasionally kills; her span of life has been shortened: in short, she has suffered loss after loss.

The net result is an impoverishment of the individual in every respect. The drone is poor, the queen is poor, and infinitely poor the vestal. This whole love state is a wrong road, with its huge social institutions built up entirely on sexual life, on reproduction, on love; and yet showing retrogression in this very matter of love, on the spiritual ladder within love itself.

That is instructive, far beyond the little bee in the heather. Al-

though by no means a state in the practical human sense, the bee state is a capital example of what one might call the "socialization of sexual relations." But at the same time it is a vicious example. It welds many thousands of individuals into a highly ingenious, uniform association. But by employing an inherently faulty method of love as the fundament, it builds a gigantic dungeon whose crystal-sharp form has something æsthetically fascinating about it, but in which the individual lies pitifully bound and gagged; and it does this instead of blazing a true trail for mobile progress. Something like a warning sign towers here. On the one hand, there is the unmistakably great advantages of a social union in a gigantic protective association where every individual has the support of many thousands of others and where the happiest division of labour in life's housekeeping becomes possible. But on the other hand, there is the grave danger that certain institutions, such as the totally deficient and crude regulation of sexual relations in the bee state, will be elevated to a reason of state; that they will thereby lose their inherent mobility for further development and ultimately lie soulless, like a petrified block, across the comrades in the association, crushing and paralyzing all.

The bee has found no way of escape from its pagoda of love. In it and by it, the bee has become absolutely petrified, and has come to a standstill forever. And, in a certain sense, the bee is the acme of the entire arthropod race, which butted against a hard wall and stuck fast in similar "state formations."

Besides the bee state there are two other large-scale starts toward the organization of a state in the insect world. Both are "love states," more or less. And both are just as unfruitful in that respect as the bee state.

The one is the ant state. In contrast to the bee state, it lacks the last vestige of a monarchical constitution. Like the bee state, it has three kinds of citizens: males, females and "female workers" whose sex is totally stunted. Frequently the workers are further differentiated into genuine working ants, which tend the young, and big-headed, able-bodied soldiers, but that is incidental for the question of love. Here, too, you have the very glaring contrast between individuals: males, whose entire task in civilized life (for a certain kind of civilization has undoubtedly been reached with such an insect state) is concentrated on the one moment of copulation; and females which do absolutely nothing but let themselves be copulated

with and lay eggs. It is a harem existence for both parties, with the entire work of the state in the hands of life-long, natural eunuchs, to whom love remains an absolutely foreign world.

The second case is the state of the so-called termites. You know the black customers in your kitchen called cockroaches. The housewife is accustomed to take them for "beetles." But they are not beetles, even though they are insects. They form an insect group which is much closer to earworms and grasshoppers than beetles. Close to this entire group is the airy tribe of the dragon-flies and of those day-flies, and to these you may now add the termites or white ants, in many traits antlike animals, which yet are no more ants than cockroaches are beetles. You have heard of the building works of the termites in the tropics—colossal structures such as no ant ever achieved. The termite state too is a love state with copulating males, an egg-laying "queen," who in the fulness of her strength when she teems with eggs, is bloated like a little potato, and several sorts of sexually impotent, stunted individuals which constitute the state's stock of "workers" and "soldiers." A harem régime and eunochism here as there. A blind alley in the evolution of love in all three, termite, ant and bee, the highest in intelligence of all the arthropods.

There was nothing to this division, that is the answer.

Not the arthropod but the vertebrate was destined to shake the world to its foundations; the vertebrate animal which raised itself to man.

But a new tune begins there. . . .

PART V
MAN

Join ye, the Glorified,
Rise to your goal!
Airs are all purified,—
Breathe now the Soul!

Faust, PART II

§ 1

Thou art the youth standing upon our graves:
Thou long hast stood there lost in meditation,
A sign of comfort to us in the dark—
Higher humanity's inauguration.

NOVALIS

IT is Walpurgis Night.

Owls are hooting in the black pine forest. They call each other, follow each other and answer in a ghastly gay dialogue, now afar, like a single hard metallic sound, then suddenly right over us—shrill spectral bleating. It does not sleep, and has the whole woods all to itself at this hour before dawn.

Halt! We can go no further here. Something stretches between the pitch-black pillars like a greenish-white cloth. Withered spider arms push their way against it. Hold fast by one of those spider arms, sit astride it. They are pine roots which hang out over the cataract of sand like polyps. The shore is hollowed out here and drops precipitately; and the lake lies in this fog which stands directly against you like a pale wall. There is some moonlight in the fog, from the distant silver disk somewhere above it. You smell the sharp breath of the mist, like the smell of a steaming monster that lies on the boggy reed-rimmed shore and spits like a cat; the whole marshy ground in which it has settled smokes.

And yet there is a peculiar magic in all this cool dampness.

A very soft sweetness, that touches your forehead as with the most delicate ghostly finger-tips, emanates from the small, young green herbs which bloom down there, invisible; and out of the mossy earth, even out of the sallow sand here, an almost inaudible, fine crackling as from heavy rain—burrowing, which the grey misty night does not check. Walpurgis magic. Flower pollen floats through the fog. Love slumbers among the reeds. The resinous branches bless it; they are awake. It is spring. Nature rings, very, very softly humming. . . .

Dreamer Man, you wonder being, youth on our graves, what are you brooding over?

. . . What did you say? Man is descended from monkeys?

Why, every child knows that.

Professors teach it. The philistine begins to believe it. The children of God and the children of the world are at loggerheads over it. And yet, the greater mass of mankind has been frightfully deceived with it. For the proposition does not read that way at all for them.

The question is, whether we have already evolved out of the monkey in our own selves; whether we, each one for himself, are really human beings yet.

The true boundary between animal and man does not lie in the grey of primordial days, between skulls of which the one surpasses the other in brain capacity by a couple of cubic inches.

It runs straight through mankind of to-day like a colossal, bleeding cut.

It separates man who seeks knowledge from man who merely lives.

The man who merely lives is to-day not one inch beyond the animal. He cannot be descended from it, for he still is it. He sits like a maggot under the bell-glass which covers the cheese, with this infinite cheese mountain of life before him. He eats greedily and pushes and asserts himself, alternately with maggot pride and maggot resignation. Occasionally he dashes against the big bell-glass, which is hard as a rock; then he blubbers because something fell on his head, for which he then invents a name, any old magic or Shamanic name out of his nursery days.

But the man of knowledge smashes the bell-glass with his first thrust and sees stars shine, worlds and Milky Ways.

The former man is still the sport of a thousand uncomprehended, blind instincts working in him; inheritances, adaptations, protective means, cautions and considerations of transition man—all exactly as the animal has it. The other man, however, has already staked all that he is worth on a single final adaptation: conscious thinking about the world. No animal possesses that. This man is beyond the animal.

And this is the man who can calmly say that his primordial ancestors were really animals, with hair and claws and tails, like

Satan in the legend. It does not worry him any. He himself is out of the animal; and that is the main thing.

He looks back into the thousands of years of civilization's evolution.

And there he ever sees the two banks.

He sees a small band which leaps over. Those are men! No external rank marks them; on no account—as if they had leaped over on the spring-board of crowns, coats of arms and appearances. These are naked souls, but with flashing eyes, with a look of longing which melts iron chains like snow. The best of all the ages are over on that other bank. Buddha was a man. Socrates was a man. Spinoza was a man. They all were descended from the monkey; they had overcome it.

But those over here may come to blows over the proposition or take it quietly, as they please; they will always be wrong in any case, and it will ever remain a thorn in their flesh. They are not descended from gods, as they would like to have it. They are animal, and no sons of deity. But on the other hand they are not yet descended from this animal. For they are animal still. Thousands of years ago there were men who were no longer animals. To-day there are still thousands of men who are not yet human.

This cut, this red bleeding cut, the true birth wound of only the living animal and man who seeks knowledge, extends through every special field in human life.

We are discussing love; man's love now.

You say that man ascended from the monkey, and, lower still, from many animals, right down to the original cell. Darwin teaches that. A new wisdom of our times starts here, and therefore man's love problem too must be regarded from a new viewpoint. But before we can talk about it, you must first be absolutely clear in your own mind about this one thing.

That crucial cut separates man and man in the conception of love as well; man in the every-day sense and thinking man. If you see this clearly you will at once see something else which has a special bearing on our case.

Walpurgis thrills of Nature waft about you in this lonely hour of musing. Throw your "knowledge" overboard. Simply live. Swim, reel and splash in life itself, and bring Walpurgis intoxication into this life with a woman in your arms; and nothing more. You want love; not a cognitive concept, but wild action. Now you think

you are one with Nature round about you. What separates you from the flower pollen that trickles on the breeze, from the enamoured owl calling up there in the pines, from all the longing and fermenting in bird and beast and flower and tree, down to the mussel on the bottom of this fog-curtained lake? They feel as you do, you as they.

Poor fool!

That too is only a delusion.

You are still an animal. But you are no longer the whole animal. You are not yet man. But you are already walking with your head covered on the road to man; walking on that blood-red knife-edge. You, who want only to live, no longer live and love as do tree and mussel and owl. A colossal corset has wrapped itself around you, composed of all the attempts, the pathfinding, the adaptational experiments of the stage between the genuine low animal and genuine man of the summit.

This applies to your love as well, and to it above all.

You want to love freely in this sacred summer night, without knowledge, without the light of thought. And what does embrace you with its claws, like the hydra of the myth? Fear, anxiety, shame, prudishness, moral scruples of every sort, a million forms of inhibitions and doubts. You are stuck fast in sweat and torments; you are no longer tree and mussel; and not yet the man of knowledge. You want to live in love; and a dark red suffuses your honest face—the red flush of shame. Seek the mussel down there in the fog, ask the wild flower's speck of pollen longingly floating on the Walpurgis breeze, if they blush in their dream of love?

An old legend rings with a truth that shakes you. It is only a partial truth, to be sure, for the legend is old and it knew only in part about mankind. Adam and Eve are in paradise, naked but happy. They live and love like mussel, flower and tree. Their life is their thinking; there are no two kinds of things, no old and new for them. But the tree of knowledge grows in the garden of Eden. They eat only one apple from it. Then they are seized as with a sudden chill. An angel with a flaming sword stands before the paradise of Nature. And they are out in the bare field, solitary. They see that they are naked. Their love is sin. They make themselves aprons and cover their sexual parts. They are no longer like mussel, flower and tree. They are driven out, lost, fallen, accursed. . . .

The legend ends here. It is the fairy-tale of the millenniums of mankind in the making. The legend ends, however, not because it is over, but because at the time it was invented no continuation was known as yet.

Thousands and thousands of persons are still at this stage to-day and therefore they rightly hold this legend in high esteem as a sacred tradition which can never go further. But during the intervening thousands of years, that conscious little band has clambered over the red divide into new territory. And they have found the continuation with which the legend first becomes truth.

Adam and Eve had nibbled knowledge on the sly, but had not resolutely fed on it. They were only pre-man, the forerunner of man; no longer animal and not yet human. They lost the simple life, but of knowledge they had only a mouthful as yet, just enough to taste bitter. A long, long trail of wandering began here. But one day Adam and Eve came back to the gate of paradise. They were naked again and laughed over the bearskin which they had wrapped around their shivering loins in nameless fear that first time. But over their new nakedness there now streamed something like the brilliance of a diamond. They had really become human beings now, human beings who demanded knowledge and did not merely want to nibble it on the sly. And in the face of this demand, the old seraph with his flaming sword faded away like a phantom. They entered the garden of Eden and lay down to rest under the tree of knowledge. Every leaf was a Milky Way, and every red flower a new stage of evolution. In the shade of these leaves and these flowers there was no longer any nakedness making one ashamed. Knowledge was again stark naked as a June rose, on which even the most bashful person will not put a bathing suit. And yet, knowledge was no longer this rose. Knowledge was man.

Only when you have grasped this conclusion of the legend can you go with me on that long, waste, hard wandering over the heath, which Adam and Eve had to go through on this side of paradise; from the point in the history of human love, where man dully sensed that he was no longer an animal to the point where he was no longer an animal; from the hour when Adam and Eve pulled little aprons over the organs that to them seemed most animal still, to the little apron in the sight of the eternal stars of the universe, and says: "I was an animal; I am one no longer; why am I ashamed?"

hour when calm, consecrating knowledge smilingly removes this

§ 2

Out of what animal grave did he climb, the youth on our graves?

The derivation of man from the animal seems something so eminently sober to-day. The characteristic of our age is that it would like to recast its new knowledge in as grey sobriety as possible. See how small and commonplace the giant man becomes under our glass! There is nothing wonderful, nothing exalted about him at all; man is just a very simple fact of evolution like every fact.

This interpretation results only because a construction which is entirely arbitrary on the part of the beholder is injected into these great new probabilities of evolution; the construction of a totally flat, two-dimensional man, lacking all colour of depth and all darkness of depth. What we in truth are trying to explain and what we should deduce in this new evolutionary fashion, is the entire man, man of the third dimension—depth. We must explain Prometheus and Faust; they are realities, and our explanation must not ignore that fact, but must proceed from it.

We talked about herring and sticklebacks, about day-flies and root-crabs, about the spider and the queen-bee—a mighty menagerie of love. Our glass, with which we have been observing, now becomes a mirror. And you yourself are reflected in the mirror.

At last, only you remain; but you in your largest sense.

You, in your deep mysterious split duality as man and woman, becoming unity through love alone. You as the youth eternal of your millenniums, as a huge organism which puts forth peoples and nations as a pear-tree does leaves, from whom these races rain down again like withered leaves and these civilizations fall like white blossoms whose life is spent, which have fulfilled their service to love—and then both are put forth anew, on a higher branch. You as thinker and poet, as worker and dreamer, as man of might and man of longing, as one striving and doing, as the being that is imbued with self-consciousness, and, in this self-consciousness, as the eternal sufferer from hunger for the ideal.

Has the idea that man stands before you now pierced and shaken you to your innermost self?

Dive down into the green depths of the sea for a moment. All that unkempt miscellaneous crew of animals about which we spoke swarms and stares and swims down there. The sea-hedgehog burrows in its hole. Red starfish lie on the sand, like thick rags. A sea-anemone, its soft moist body bent like soft gristle and its tentacles welling forth like a half-opened cauliflower, is gently moving. A silvery-blue fish bends the golden purple leaves of the florida apart. A rose-red jelly-fish climbs up the emerald column of water in slow thrusts, as if it were breathing. And now, with a sudden jerk, you are up above, entirely out of this phantom world: you behold a free wide-open surface on which the wind plays; blackish cliffs; wild isles with shrieking sea-gulls; and on a cliff sits a young girl, with her naked little feet in the water, and she laughs out of bright self-conscious eyes and sings a human song, over the rocks, to the sea-gulls and the wind. Man!

Or you wander through the lonely desolation of mountains, through the wild gorge of a mountain pass beyond the tree-line. Above you rise cracked walls of rock, eaten by erosion, and at the top only the clouds hang, like grey balls of cotton batting glued fast. The brook beside you is torn into white foam, its noise drowning every other sound, and under foot, little stubborn clusters of alpine roses, like dark green brooms, bend obstinately. A bird of prey is wheeling in the pale blue segment of sky above you. Everything is gigantic, primeval, as on a strange planet. And then suddenly you think you see yourself, the tiny wanderer, small as a pin-point, climbing up this desolation of mountain range step by step, with thoughts simultaneously mounting inwardly, step by step, Promethean thoughts, the thoughts of a scientist, of a philosopher, of a world reformer. And suddenly man appears to you as the utterly tremendous fact.

What is that green aquarium full of the sea's odds and ends; what are those few crags with their cloud smoke! The brain of that little girl yonder is an infinitely more wonderful ocean depth. Your thought, which dives in mountain chasms, is the great mystery; in it is everything: the crag, the eagle, the alpine rose, the primordial world and the present.

Now say to yourself that this happened once for the first time. In utterly distant days, man appeared for the first time, as something new. Incomparable hour! Old earth, rolling around the sun, green-

ing with the Walpurgis joy of spring, as so many thousands and thousands of times before—and there was man on it. . . .

The fog over the lake is rolling up and moving. A light breeze has sprung up, like the very first greeting of dawn. Over there, of a sudden a black rift is blown in the greenish-white field of fog. A reddish light hovers ghostlike between heaven and earth, coming from the little village, which lies invisible at the entrance of the lake. The fog seizes it above and below in its white arms. If it lets its arms sink a bit, it will bury the light again.

And I feel as if the eye were slipping back through the centuries and the millenniums, ever in this green mist, with this red light ahead, on back and back. Out of all this mist, the age-old thought of philosophers sounds in me like soft music, that the things of this world are an eternal present, an eternal being and becoming holy, and that man who has become man alone trains the concept of time like an adjustable microscope on this immeasurable cosmic carpet, now moving it upward, now downward, as past, as future, as now. . . .

The microscope moves on and on, over railroad lines that are straight as an arrow and whose moist metal flashes between the red heather and the soot-black pine forest; over old, bad country roads on which the stage coach rumbles; over feudal castles and gay Gothic windows; over wild woods in which the hermit prays while the wolves howl without and the horrors of war rage afar; over Wendic idols, before whom the red blood gushes out of naked, convulsively twitching, snow-white human bodies into sacrificial basins; over green Germanic border barriers, where wild roses bloom, and shining rings of stones on the heights, around which the juniper-trees tower like cypresses . . . and then on into the utterly heavy, utterly deep, utterly colourless fog.

There are ghostlike voices in the mist, as if coming out of the void.

The shriek of the wild swan, nesting in the tall reed of the lake; a dull roar—the giant cat's cry of victory, the cave lion which has killed a rhinoceros calf. In huge heavy balls the fog rolls through the phantomlike branches of huge trees in the primeval forest, and sinks down on the dark, melancholy lake. And there is the red light again, the flame of prehistoric, primitive man's hearth. It is his own light; a flame which lives with him, tamed like a domesti-

cated animal; an artificial flame, which he himself knows how to kindle—and by the light of which he loves.

It is the star of mankind.

A new song. A new era. New love.

Never before had the earth shone forth with a flame like that; this old earth, which perhaps itself ran down like a drop from age-old light.

As the fog sinks down on the lake, it leaves the heights free. And the stars flash up through the torn shreds of mist dropping down; the wondrous dome of heaven, across which the silvery Milky Way flows with the quivering beat of the æons, and golden Capella, red Aldebaran, and white Vega.

Perhaps the earth was once upon a time a dazzling white lily of the universe, like Vega. Slowly the silver became glowing gold, till the earth was like Capella. And the gold in turn acquired a red tinge, like Aldebaran. The red molten glow proclaimed the coming night. Rusty red spots of fermenting matter forming mixed chemical combinations periodically clouded earth's shining shield. Like the wonder star Mira in the constellation of the Whale, which hides from view for many months only to flare up again and ever again in red-glowing intensity, the earth may have disappeared entirely from view for a time, only to pull itself together again, like the spark on a candle-wick which gleams brightly once more before suddenly going out. But then the earth's rôle of light for the distant universe went out for good. Never more did the whole globe shine; from now on, only the pale golden sunlight was reflected from one side and made the white now of the one and now the other polar ice cap flash in the course of the year and painted the blood-red of its dawn on the dark rims of the dark globe. And like the ghostly gleam of a dead world, only the silvery breath of the moon, itself merely borrowed light, fell on the night side. And now and then a last greeting from the earth's own solar strength came from below like sparks. Lava broke out of the raging volcano like a liquid ruby and illuminated the surface of the sea with its hot red glow at night. Blue lightning flashes quivered through the atmosphere. Green and violet shooting stars and balls of fire flared like a match scratched on the huge whirling ball of air during its solar journey, and periodically united to form dazzling fireworks. From the magnetic poles, the northern lights and southern lights poured out long multicoloured streamers toward the belly of the planet. But then, gradu-

ally, very much more discreet and more mysterious, a very fine light effect of a higher sort appeared, as if the star which had gone out were trying to recollect some brand new way of making light.

The sea is black, without an atom of moon silver. Suddenly it seems as if a shimmering emerald cloud with golden stars, big and little, woven in it, were lifted out from below. And the entire ocean awakens in living light—the phosphorescence of the sea. It is living light, light which is lit by life. Myriads of tiny beings, many of them one-celled beings of the very lowest order, radiate the green brilliance from the living substance of their bodies; and larger animals rock like burning tapers and balls in the universal day. Life has conquered light, at first in its own body. Life carries its torch down into the deepest, ghastliest abysses of the ocean. Its flame flows around red starfish on the bottom of the sea like luminous green sod, the animal colony of a coral reef seems to glow through with an electric greenish-blue and the deep-water fish malacosteus emits green and yellow rays of light as with a searchlight from directly beneath its organ for receiving light, the eye. Up on land, the fire-fly, whose golden-green star can still take the place of a lantern and enable you to read a book by it to-day, whirrs in the black, moonless primeval forest.

But a tremendous period of time still has to elapse; and then the red flame shines.

The red star of the flaming hearth around which the lions of the primeval age roar and singing swans shriek, is living light too. The tree giants of the primeval forest will crash down as if struck by lightning and their place will be taken by the great city, with its blue sea of electric light. The night train will thunder across country on iron rails like a serpent with luminous scales. Light signals will fly over the oceans. White ribbons of light will flow into the twofold night of the mine which burrows in the grave of the carboniferous period, and of the tunnel which parts the granite blocks of a snow-covered mountain. The submarine with its searchlight will dive like a sun into the abysmal world of the polyps, starfish and deep-water fish. Light will flow for man from every rock that is smitten; the gentle fall of water will become a golden source of light; the buried primeval pine forest, turned to coal, will strike a light for him. As in a book, he will read in the light which his spectroscopic apparatus has split up who the stars are and what made the world before he existed. He will sink to his knees before the light;

as a child, before the burning bush of thorns out of which Jehovah speaks, and as man, before the eternal divine force of Nature, which is at work in light waves as it is in human brains.

Those are men who are looking after the little red star over there, the wonderful last light which the planet gave birth to on going out. Man is here!

Yellowish-black storm clouds had piled up. The storm came riding wildly, like one of the horsemen of the apocalypse. It crashed with elemental force into the groaning branches of the primeval forest, which no civilization had touched. Decayed trunks, dry as tinder, which only the network of creeping plants still support, stir like ghosts and totter. The whirlwind bursts into the open fields, laying low everything before it. The yellow grass rears, dry thistles crackle, along the marshy lake the brown tribe of reeds and bulrushes rustle and rattle. There is a flash of sulphur and a thunder clap, and far and wide continued red illumination. The mighty oak with the decaying ruins of trees leaning against it, the primeval forest smokes and steams. And the wind hurls the fire into the parched prairie. Far and wide, a huge, blood-red sheaf rises on the horizon. Large animals stamp past in headlong flight; flushed birds flit like black shadows ahead of the fiery brightness. Suddenly the threatening cloud hose bursts. Infinite rain falls. The flames are smothered in dense white smoke. And the ægis of yellow clouds tears apart, revealing blue sky. The last smoke drives away with the clouds of night, and the scene of the conflagration is again accessible. Animals of all sorts come back, lured by precious booty. There are charred, singed, roasted carcasses everywhere. Four-legged and feathered ghouls get to work—the wolf creeping close to the ground as well as the falcon which strikes out of the smoky air. Ruminants lick the salty ashes and warm themselves on the comfortably heated field. But another being has experienced and profited by the fire. Night has fallen; only the still stars are shining, and here and there a glow-worm in the untouched depths or the woods. But there is still a red flame over there—a solitary flame, far from the great conflagration. Man has saved it. He watches it with infinite care. The wild wolves have a cheap roast done in a delicious, black, salty crust for dinner, but only to-day. Man, however, will have it just as long as he keeps the salvaged flame. The game which his arrow kills will always be roasted the same way by this flame, "his flame." And roasted meat and baked fish will keep

longer than had ever been possible before. This flame is a sacred possession. The wanderer must carry it with him like a talisman. And he discovers how this mysteriously benignant being, red fire, can be fed and kept alive, even on a journey. Smouldering wood-dust is carried along in a hollowed-out tube, a hollow staff. This dust is made by rubbing wood into fine particles, by rubbing wood against wood, and by boring wood into wood. The rapidly ground wood-dust, the wood "flour" kindles, smoulders, and chars of its own accord, according to the laws of transformation of motion into heat which only to-day have become manifest to us as laws. And man grasps the fact that fire can not only be preserved but also generated. He beats a stone into a suitable weapon. Sparks fly. He adds some tinder and obtains a flame. He now has another means whereby the artificial generation of fire becomes an act of the will and of mastery. And the red flame glows whenever man wills and wherever he wills it. He is Prometheus, carrying the luminary of the heavens in his hollow staff, and no longer a blind animal which merely seizes the opportunity afforded by the burned steppes in its lust for prey, and enjoys it once but is never able to find it again. Man knows how, ever anew.

Man in his entirety is contained in this "ever anew."

His hearth goes out a hundred times, and a hundred times he kindles it again. His spear and his stone weapon break in two a hundred times and a hundred times he makes them anew. For things are implements to him, externally projected organs, which he can generate when he wants to.

He does not need the glow-worm's shining body nor the lantern of the malacosteus fish, grown fast in the substance of its body. His brain encompasses all of that in the one remembered possibility, that out there in the world he can generate light and fire as often as he will.

He does not need the rhinoceros' horn nor the lion's jaws on his own body. For his brain and hands will make horns and canine teeth at any time for him out of a piece of flint. This whole infinite collection of stones, hard as steel, which the glaciers of the ice-age first sawed out of the chalk and strewed over the plains of northern Europe along the edge of the receding wall of ice during the hard diluvial period is his horn and his set of teeth with which he will subjugate the rhinoceros and the lion and be their lord and master.

Rhinoceros and lion first, and in the end the whole earth with all that lives thereon.

He will become this earth's perfect form of adaptation. He makes a new giant body for himself with his implements. His new nerves stretch over all lands as an electric network and run on the bottom of the ocean from continent to continent as cables. As dynamite, his projected muscular strength blasts mountains; as the force of the lever it moves iron blocks, before which the might of an elephant is as the push of a child's hand; he uses Niagara for his own purposes as a monkey does a green twig in the primeval forest. With Lord Ross' giant telescope, whose mirror measures almost three square yards and whose tube is eighteen yards long, his giant's eye stares into the world of nebulæ and plucks down the moon to within seventy miles. He catches the bacillus, whose diameter is only one fifty-thousandth of an inch in the microscope. An attack with his new members, his implements, makes the waters of the Mediterranean pour through the Red Sea into the Indian Ocean; the potato plant spreads over all Europe from a corner of Chile; woods are sawed off and an entire region is reduced to waterless, rocky paralysis, all its water courses are changed and it acquires a new climate; or conversely, a canal is built, and the desert blooms, the sea of slime and ooze dries up. Fata Morgana and the Flying Dutchman become real orange groves over the blue sea and a real white sail of civilization's ship which drops anchor where caravans once perished from thirst. There are no longer any limits on the entire globe to this fairy-tale body. It bores into the depths like a colossal root; it stretches into airy heights like the tallest scion of the sun.

But a little longer, and this whole rushing, roaring planet with its ten thousand trillion tons of freight will belong to him, as a statue, which is merely temporarily in the mould, belongs to the sculptor. Every second of the globe's solar journey is one more blow of the hammer against the crude covering, liberating the work of art—man's work. Do you hear the soft whistle of the locomotive coming afar over the woods? The hammer is dancing even now, in the still night, and the decayed covering begins to quake: his earth, man's earth, flashes through the rift, with man entirely adapted to it, as the absolute adaptation, the highest that life can attain; and then the great change—the earth adapting itself to him; both inseparably growing together; man to the earth, and earth to man; the earth his body, and man its spirit.

We are to talk about this earth spirit's love. It too is a love-child under the universal spell of love.

But what love procreated it, and where and how?

Haze, smoke, and mist. The red light of the flaming hearth, about which men of prehistoric times huddle, shines out of the mist. And the great question goes back into the mist.

Man himself, highly developed man, is asking about the date of his birth.

His cities sparkle with light; his voice rushes across continents and oceans. Before him lies the universe toward which he is swinging himself along with his earth. The sun is carrying him toward the constellation of Hercules. Wonderlands of knowledge, of freedom, of love stretch out before him in the luminous haze of the future. He will conquer them and will live in them, under waving palms and beside murmuring fountains, as a royal child of the solar system. He fought his way up under fairy-tale circumstances. He himself fashioned and sharpened his colossal sword. And then he stood it in a corner and let dust settle on it, and garlanded himself with roses and struck up golden songs, and drank in the light of suns and Milky Ways with flashing eyes. Man came down to himself as God, first in the storm and finally on the light wings of the zephyr. As Buddha, he comforted himself; as Christ, he became reconciled. As Kepler and Darwin, he received the world into himself. As Phidias and Michelangelo, as Shakespeare and Goethe, he laid the corner-stone of his own superworld. And after the millenniums whose roar still rings in his ears, he is still standing here as a youth. Not like Moses who sees the Promised Land once by the light of life's evening and dies, but like Moses, the child, who wakes up in his little boat of reeds on the sacred river and stares with big eyes, which are clear as the morning, over the carpet of red lotus flowers.

And this man clutches his forehead.

Where did he himself come from?

He tries to recollect dully, like a mad drinker at the Feast of Bacchus, to whom all noises sound far off and the torches shine darker for a moment. How did you get here? What are you, any way?

§ 3

Two roads lead to the answer.

If you happen to take the right one, you also have the key to man's love in your hand; the key to the love which procreated him, and to the love which still procreates in him to-day.

The human spirit is so very mighty. How could it be possible for man not to have the solution of this mystery too in his depths? You proceed slowly through the mist down there, with nothing before your eyes, your entire vision turned inwardly. And you ponder.

What do I myself know as an individual, after I have been in the thick of roaring life for forty odd years and suddenly stand still, look into myself, and ask myself: what do I know of my own knowledge about my birth?

A chain of memories rattles down through my life: first, a whole mass of memories which are still quite clear, quite near—occurrences, pictures, persons, scenes, pain, happiness, colossal blunders which I now feel I have gotten over, and a few useful steps that led somewhere. All this is quite unambiguously my own experience. And it continues on down and down, until everything grows ever paler, ever less distinct. Actions rise up which are foreign to me, inwardly strange as well. We did all sorts of silly things when we were young, because we did not know any better. But could I ever have acted so heart-rendingly stupidly; could I ever have been so green, so "childish"? Going still further back, I find only phantoms: a black and gold tapestry in a strange room; a garden, and voices which I know perfectly well, and yet those voices are no longer connected with any persons in my mind; a street—I think I know every cobble-stone, but I no longer know where the street is. I must get a report on it. You were a child at this and that place, and older people still know about it. But when I take one step more, I know absolutely nothing more.

I am lost now, lost forever, as far as my own memory goes. From now on I only know things through others. But even this thread gets thin. Here is a date of birth, with an official seal on it. That is irrefutable. But what is "birth"? An organism, which was

already "mature" in a certain sense, became detached from the mother, after nine dark months. I already "existed" in the first month, but I was not yet a human being then. Natural history teaches me that. My embryonic form did not even resemble that of a human being. And in the final analysis, this embryo came into being as the result of an act of procreation. . . .

My life dives into utter oblivion at this point. A veil is drawn over my parents, and their sacred feelings of love. And now, as a twofold being, I enter into both: I enter into the one as a sperm-cell and into the other as an ovum-cell, each of these cells being in the giant association of a different body. The light is totally dark now. Human traditions passed on by others, human confessions no matter how intimate, are no longer of the slightest use to me, for I have come by chance into the ultra-violet wonderland of philosophy.

So much for me. But how about "mankind?" Humanity has no fellow-men, no uncles, aunts, or parents who can tell tales. Mankind grew up like Kaspar Hauser, as far as tradition goes: a few thousand years of kings, priests, empires, and slaves, just as to-day, perhaps a few more follies, but also some profound wisdom gathered. Furthermore, mankind kept diaries about all this, in cuneiform, in hieroglyphics, in Chinese tea-caddy characters. But what next? For mankind, too, there are only golden-black tapestries and cobble-stones, I know not where; and a green garden, where I sat under an apple-tree. Where under the sun was that? No one knows where. For no second party was present who could tell. Answer, please! Answer! Plough up the terrestrial globe and see if you cannot find a child's toy lying around somewhere; if the roots of the apple-tree, around which you played, are not left somewhere. But what do even these prove? They show what you were as a child, but you were already a human being then. Where is your birth certificate? And where is the mother's womb, which gave birth to man? And the holy hour of procreative parental love? Poor humanity! You are the flower of the earth, and you have no better documents from the great beyond, beyond your remembrance, than has a Kaspar Hauser, whose origin was so violently and cunningly concealed. . . .

You to-day suppose that you alone think this. But pure thought had already arrived at this question thousands of years before you. It got stuck just as fast and at the same spot as you; but man's intellect refused to let itself be beaten. Pride of spirit rebelled against this. It tackled the problem with arbitrary power and cre-

ated an imaginary picture for itself which struck it as being big enough to be the solution. As a pioneer in its inmost nature, man's intellect wanted to battle its way through at any price. The fact that you, as an individual human being, undoubtedly must have lived in the womb before the statistical fact of your birth, together with all the premises to and including the act of procreation, all this you tacitly get from "natural history" as something which is a matter of course. It really cannot be otherwise, and even the prude will admit it on condition that one does not talk about it.

But what about mankind? Here the dreaming spirit thinks that it must reach out to the most wonderful, the highest, the most gigantic things that can be imagined. Mankind's first "man," they say, came "from God." You know how it happened. One day, the first man sat under an apple-tree. Before that, he did not. Creation out of the trap-cellar balances on the thin edge between this "one day" and "before that." That is as far as pure thinking can go.

A huge spectre stretches out of the mist before you here at the rim of the sea. It is a human shadow, magnified to gigantic proportions. This is no longer the rim of the sea over which it towers. This is the eternal coast of the world. Here is the world, and yonder is nothing. The sound of mystic murmuring descends to the white sand of the shore, making it move in the mazes of a spectral dance. . . .

God made man out of a clod. To dust he shall return, even as he was formed of the dust of the ground.

God and dust!

Countless persons have been comforted and edified by this idea. You yourself grew up with it. Your deepest religious sensibility clings to it. If some one calls out to you that it no longer holds good, you feel as if the loveliest column which supported the sky-blue of your thoughts about the universe were tottering. . . .

Nothing is further from me in this sacred Walpurgis hour, when all the spirits live and let live, than to wound your religious feelings.

If I were to be granted a wish, I would wish that human beings to-day, all of them without exception, might be many thousand times more religious-minded than they are. Religious in the sense of deepest longing, in the sense of that verse, "I will not let thee go, except thou bless me"; "thou" being the riddle of the universe. And no less have I the greatest respect for the striving, wrestling

spirit, wherever it has fought on and obtained an answer from itself, no matter what the answer may be. But I have learned something from the history of such answers. Pure spirit is an embezzler. What it mostly takes in a case like that is not actually false, is not too weak nor too small—but it is too big. It will be hard for you to get that idea into your head, though.

God and dust!

Both of these concepts have automatically continued to develop in us to-day, not among the scoffers but among earnest people. And that is why they no longer tell us anything in that old sense.

It seemed so infinitely simple when it was first proclaimed. Yes, that was the way out: God and dust. Everybody knew what that meant. God, the old superman in his golden splendour, who could do anything and everything. And a little heap of dust, the poorest thing in the world, which a puff of air blows away so that you cannot find a trace of it. These two words constructed a network between heaven and earth, in which the infant mankind lay quieted down as in a cradle. Where did that easy age go to?

God.

Iron human toil itself forged this word.

In the world of Homer, Zeus still appears as a jolly good fellow taking a walk through a nature ruled by fate. Pretty girls sit by the world's wayside, and he kisses them. But this world along with the sun and the sea and flowers happens to be on hand quite apart from him. He is merely a somewhat bigger, stronger human being in it. He is already the master of electricity, and hurls thunderbolts where Achilles can merely hurl spears. He sees through walls as if with X-rays. He scatters the bacilli of pestilence over a Greek army, whose doctors have not got any microscopes as yet. He flies through the clouds, as did Montgolfier's balloon barely two thousand years later.

How nice and small this God still was!

He had human beings in his power merely by virtue of a few improved technical abilities. But he was far from having nature as a whole in his power. And he never got hold of even man in the depths of man's inner world. The passions and the inner destinies of the gods were only a pale reflection of the colossal thing that really lay deep down in man. Man, when he stopped to think about it, was greater than his God. And he finally did think about it.

God received a new kingdom, extending down into man. Under

the sacred fig-tree on the Ganges, which still murmurs of Buddha to-day, God for the first time fell on his knees before man, gripped by the colossal thing about that moral destiny in the depths of the human breast. And God broke his kingly crown into pieces and became entirely man. And he took this colossal thing, the one-half of the world, up into himself. This was the same God who spread out His arms on Golgotha, to embrace all mankind; those arms were fastened with nails, as proof that the matter was not so easy. And yet in them He caught what He wanted to.

More than a thousand years now pass. A new age ripens. And then the other half of the world is joined to that first half. Knowledge about nature unlocks the universe. And this cosmos becomes merged completely in God. The depths of the unfathomable sea of stars are added to the deeps of human destiny. God, who had become man, now becomes Sirius and Aldebaran, Vega and Betelgeus; he becomes the whirling maelstrom of the spiral nebula in the constellations of the Greater and Lesser Dog, and the ring nebula in Lyra. In this giant body, the entire path of the sun from the flaming cosmic worlds of Orion to the distant stars of the future in Hercules is a very tiny artery through which a blood corpuscle hastens. The mammoth trots, the ichthyosaurus swims, and the earth dances like a mote out of the night and back into night again in God's unfolding of time.

That is what we and our God are now.

Everything is merged in God, even to the last glimmering stellar dot in the universe; all natural law in God; all energy, which is indestructible and which is merely transformed; all of Darwin's natural evolution, utility and adaptation and the ascent by natural selection, all merged in God. In God is all inner life and the perception of the universe, about which we divine that it pours down in infinite luminous cataracts over what we call the inorganic world, and that it flames up in mighty pillars of fire, as far as millions of habitable stars move on. The telescope, which grows dizzy and sinks and is lost in Milky Ways, gazes into God's arteries. What the prism breaks up into seven gorgeous colours is God. The rock of Hildburghausen, which once was ocean ooze in which a long-lost froglike monster imprinted its track, that too is God.

"God created" means nothing else than that man, too, came into being in and through God, came into being in and through the world.

But this answer blows to pieces in the vast distances beyond Orion.

The word has finally grown up to full size. But now it is too big for a single answer. In its giant hand, man of this earth falls headlong from star to star into the inexhaustible sieve of the Danaides which is the cosmic deep. It is virtually no answer any more.

It is true that man is part of the weave and woof of this whole universe. All these stars, all these ages flowed together in man. But how to unriddle it all! How to unravel it, beginning at the hem of this tiny planet; how to solve it, beginning with this human wisdom, which is rooted here like a poor sunflower stretching out its little golden nursling's arms to the blue cosmic vault of heaven. . . .

It is too big.

We train our telescopes, we dig in the ground, we toil in every possible way with our scientific research. We bore small shafts full of darkness and choke-damp into God's body here and there. That is the right way—not the wild resounding word as a whole, which sounds so easy and which burns up in the far reaches of Orion.

And now about dust.

Lie down on the beach which is still moist from the mist, and pile up the soft sand like a child playing. Man's childish belief did not invent any sacred magic material from which the first human being was supposed to have originated. It thought of the coarse, red clay in the valley of the Euphrates. According to the natural history current then, fleas and mice issued joyously from this red clay; and still do to-day. God stuck his hand into this clay, and it became a human being—clay which otherwise would have hardened in the very next hour of sunshine and would have crumbled to dust, which the merry wind would have scattered over the countryside. Have you any idea what dust is?

Look at this little glass plate. It is small enough to carry in your pocket. It consists of two thin strips of glass glued together. Hold it up to the light from your cigar. Between these pieces of glass lies a drop of Canadian balsam, and you notice a number of very tiny little dots put to bed with loving care in this balsam. It is a little sample of dust, poor as a pinch of snuff. But read the inscription on the little label. "Radiol. Ooze. Chall. Stat. 225. W. Pacif. 4475 Fd." It sounds like a doctor's prescription, but I will decipher the code for you. Ooze is English for ooze, and Radiolarian Ooze means ooze which consists mostly of radiolarians. It is a sample of ooze taken from the lowest depths of the sea. The famous deep-sea expedition of the British ship *Challenger* brought it up with

marvellously ingenious apparatus from the bottom of the Western Pacific, at its two hundred and twenty-fifth sounding station (between the Caroline Islands and Japan) from a truly tremendous depth. It has to go down 4,475 fathoms before it touches bottom there. That is more than five miles. The highest mountain on earth, Mount Everest, could be sunk there and the biggest steamer afloat could sail over its peak without running aground. Ooze, infinite ooze lies down below there. And this ooze extends along the bottom of all the oceans. Imagine that by some sudden geological action all the waters of earth's oceans were suddenly sucked up. Endless deserts, greater in area than all five continents put together, would suddenly yawn. The ooze forming the bottom would actually fall to pieces, into dry, whitish and reddish dust on drying up. And a storm would swirl sand-spouts composed of these millions of square miles of dust up to the clouds.

And now put a sample of this deep-sea dust under the microscope. When you get it adjusted right, a fairy-like picture appears in the little island of light whose magic power reinforces your eye far beyond its usual bounds, like the treasure of the Nibelungen which rises out of the crystal-green stream and quivers in the moonlight during an inspired hour when the wine flows. The misroscope has become the magic mirror of that dwarf of Venice, which reflected all the sunken treasure of the deep. Its field of vision is thronged with silver coats of chain-mail, round Saracens' shields with buckles and sharp spikes, helmets with fine visors and long curved neckpieces, all manner of precious ornaments, rings and bracelets, playthings made of precious metals by the craftsmanship of olden goldsmiths, as if for royal children, crowns of emperors and papal crowns, sceptres and antique swords and pious crosses, and crowns of thorns as well. Much is broken, as will happen in the case of long-lost treasures. But even the broken pieces are miracles of art.

And yet, all this is no treasure made by human hands at all. This little sample of dust is a hecatomb of diminutive life which once swarmed through that huge column of water, five miles high. It consists of the hard shells of one-celled protozoans, of the so-called radiolaria, each one made of silica, the same material our beautiful rock-crystals are composed of; and constructed according to mysterious laws of rhythmic arrangement which our human eye hails as "beautiful"—made from the formless slimy bodies of those low

beings in the pitch-dark night of the black watery depths. Those shells sank down into the depths of the abyss and formed the ooze, the dust which is there to-day. There are hundreds and hundreds of wonderful forms in every pinch of dust; forms which are as perfect as crystals in the structure of their lines and which yet are already spiritualized, produced by the organic element the unambiguously "living" principle as by a sort of higher authority of Nature.

And now turn away from the microscope and picture this with your mind's eye. Each one of those fascinating pieces of radiolarian armour, into which the piece of "dust" was resolved, is composed of countless little particles of flint, just as the living cell body of that tiny first animal in the shell was composed of countless particles of vital substance—protoplasm. These little parts in turn consist of still smaller parts. The microscope no longer sees the latter, but chemistry can still get hold of them. The particles of silica resolve into parts composed of the element silicon and the element oxygen. The particles of protoplasm resolve into particles of pure carbon, oxygen, etc. The world of molecules and atoms begins here. Chemistry, which takes us along a bit further, keeps constantly coming upon new rhythmic arrangements of these particles, upon very definite relations. There is no doubt about it: ever new treasures, new kaleidoscopic figures, new crystal-like mathematical creations would constantly appear in the lap of one of these little flint shells to the really seeing eye; a swarm of them, until you would think you had moved into a new universe and were looking into a snow storm of Milky Ways, where every flake against the blue was a sun, a double star, a planetary system. And there are systems down there just as there are up yonder; systems in which cosmic forces hold sway. Every molecule is a sun in its way. There is no end to the solar universe up yonder. Behind Orion, behind the whole island of light which is our system of fixed stars, new systems, new islands of fixed stars come up like dawn, until our glass telescopic eye fails completely. Just as little does the universe of matter's smallest particles ever terminate.

Always and always, here as there, you have a sacred may-pole dance; and never, never, never an actual sinking down to irregular, wretched "dust"; but always harmony, vibrating, wedding and joining in rhythmical and æsthetically perfect forms, always the soft-wave-beat of the same great mystery, in which Orion is a wave and

you as a human being are a wave and the radiolarian is a wave and every molecule in this radiolarian is a wave.

That is "dust" for you!

And you think you have enunciated something final when you say: man was formed out of dust? You think that you have reduced the complex miracle of man to its simplest terms with the little word "dust," and that it requires no further discussion?

"Out of dust was he made, unto dust he shall return." Turn the same microscope on the invisible, tiny speck of dust which clings to your hand. You wandered through the springtime woods. The loving arms of the pussy-willow hung over you and dreamily rained down their golden dust. One of those little yellow dust petals still sticks to your hand, invisible to the naked eye in its isolation. If you could completely unriddle this speck of dust, the veil would be torn from those Milky Ways of elements where atoms of carbon, hydrogen, and oxygen wed to form systems of stars. But there is something else in this little speck of dust. Brought to the right spot, it will make a new plant grow, a new hazel, which will not only extend downward into the universe of atoms but will also stretch upward and drink in the golden light of the real sun. Into this yellow speck of dust, all the strength of all the hazel bushes that bloomed on earth for millions of years, perhaps since the chalk age, has been concentrated, so that it can again generate a hazel bush. Concentrated in the existence of that first hazel bush at the beginning of those millions of years in turn was the entire past of the vegetable race; concentrated in it were all coniferous trees, palm-ferns, genuine ferns, algæ and primitive plants together with their procreative force, right back to the first and oldest plant organism on earth at all. This oldest, first original organism however was simultaneously the starting-point of animal evolution; so that at bottom everything is contained in it, everything living, everything that we see or divine, is implicated in this yellow particle of hazel dust. The hazel is a small bush. But the eucalyptus-tree of Australia, which gets to be higher than the spires of the Cologne Cathedral, grows from a speck of dust no bigger than this. And so do the cypresses and the dragon-trees, which look down with their thousands of years on mankind's civilization as on a mere night-watch. Dust! Do you begin to have respect for this dust?

Imagine the earth swept clean of everything on it; no life, no water, no air, no inner motion in the rocks, everything void, smooth

and dead. Let them swing around its centre of gravity for trillions and quadrillions of millenniums in that way. What will come to it? What will touch it as a mysterious new motion? Dust. The universe, the wide open planetary spaces, the vast reaches of the fixed stars, incessantly bring along one thing—fine dust. Very fine meteoric dust, iron dust containing nickel, keeps continually falling on our earth to-day. You find its trace on the virgin ice of the polar regions. You find it between those shells of radiolarians in the Mount Everest depths of the ocean; always meteoric iron alloyed with nickel, coming from distant worlds, perhaps from worlds which have been blown to pieces. How many miracles of evolution, how many civilizations may lurk in these specks of iron dust as ultimate extract! Imagine this dust raining down for trillions of years. The planet would grow, its weight would change, and its course would change with its weight. Perhaps life rained down as dust, germs of life, which had defied the cold between the stars, as pumpkin seeds survive an artificial cold of 192 degrees below zero, centigrade. You see dust at work; you see how it builds worlds and alters planetary systems. Dust is like God. It dissolves right under your eyes and becomes a cosmic cloud, floating off into infinity.

Solve the riddle of dust for me and I shall throw the riddle of man into the bargain.

But the net result of our thinking is the same with dust as it is in the case of God; it is too big. It is the riddle of the universe.

The universe is a vast band of light—God. And a vast cloud of rushing dust. In God and dust there are distances far as Orion. As old Lucretius sings: "Go to the end of all known things and boldly hurl your spear; it will fly toward new worlds;" worlds which twinkle like silver specks of dust; worlds which still are God; even as Orion is, as the sun is, and as you are.

God as well as dust are no answer; they are the universe.

You must turn to something smaller and closer by, though never futile, for an answer to your question where man and his love came from on this planet earth. You say: "God formed him out of dust." And I say: "Dust is God; God is dust." Man, to be sure, is to be found somewhere along the road by which dust became God. This word does not help us any. We must look elsewhere and harder for the explanation. But where?

The keen flight of the purely brooding spirit would have been paralyzed at this point. The one way would have been barricaded.

There would have been nothing left but a certain melancholy at the end of this proud campaign of the spirit. We must really admit one thing, hard as it comes to us. In all world history that we know, from earth's primordial days until to-day, there is really nothing stranger, more touching and yet more instructive than the fact, how noiselessly, how incidentally, how almost like a mere bagatelle to the confused view, man's natural appearance on the scene of this earth took place. Our knowledge of nature possesses very clear pictures reaching back into the distant past. But this tremendous, demonic matter is hidden as if it had happened during an intermission.

Involuntarily we think that the world must have enjoyed a special holiday when that event took place. The spheres must have made music, and something like the mighty pealing of bells must have come from the loins of earth. In a chapter of the Book of Job, Jehovah asks with the pride of a true world poet, thinking of the hour when He first composed His world and His verses for the first time flashed upon him: "Where wast thou when I laid the foundations of the earth? When the morning stars sang together, and all the sons of God shouted for joy?" You expect some such rejoicing on the part of morning stars, at the very least, when man appeared on earth.

But there was nothing.

The spiritual history of the world was not a show for spectators in this sense. And at bottom, we ought to know that from mankind's later history. The morning stars did not audibly shout for joy, nor did the spheres do any bell-ringing when "Homer" composed the Iliad. On the contrary, the poet was completely lost to the point of never being found again, to the ultimate triumph of the schoolmasters who in this case, as always, like to kill off the individual. Shakespeare is to-day in a fair way to share Homer's fate. Zoroaster, Buddha, Confucius, Moses are red pillars of flame in the fog. Their light shines, and illuminates an epoch of humanity. But the hand that held the torch seems to have come up out of nothing. And yet those must have been giant hands groping there. As a historical figure, Christ, above whose cradle legend really makes the angels sing, has sunk in the black waters of critical confusion; He whose spirit once walked on stormy waters and still does to-day. Where is the man who wrote the poem of that Book of Job? You must have stood before the Venus of Milo in the Louvre at Paris in

a solitary, sunny hour and said to yourself that this ineffable beauty of a woman bears no name of an artist and that her whole continued existence depended on the brutal force, which had already lopped off her arms, coming just a few inches closer, in order to realize that world history's life is a more mysterious one than our crude senses dream. A more mysterious one, but not the less sublime on that account. "It is an eternal stillness," old Angelus Silesius sings about his cosmic spirit.

The mist had spun its net entirely around you again, so that you could no longer see a thing. And yet it was only the nearness of day itself which had made the mist so obtrusive. . . .

The road of pure intellect will not lead you anywhere. Do not torture your poor brain: you will not recall anything anyway. And if you let your imagination soar on into the blue, nothing but mist will result, either. But there is a second road. It gets light and day breaks, when you take this road. You have been thinking and thinking for hours. Look up; it is day. And I will show you the road.

A man in a fairy-tale was promised that a stranger would bring him news which would make his fortune. He is to stand on the bridge and wait until some one speaks to him; and that will be the right person. He waits from morning till evening, looks at every person of quality and waits for the lucky words. But nobody says anything to him. All day, an old beggar, to whom he had paid no attention, had been standing beside him on the bridge. At the last minute of the long day, when he had given everything up for lost, the beggar stepped up to him and proved to be the unknown man who brought him the lucky news.

May the same thing happen to you with your question about man. You storm through heaven and earth and find nothing. And as you throw yourself down here in the white sand on the still shore of the sea in the freshness of the morning, feeling desperate because you know nothing, there behind you stands the sage who can teach you everything. He stands behind you, even when you are all alone. He is with you like your shadow wherever you are. Only, you pay no attention to him. I shall show him to you.

§ 4

The mists have blown away.

The lake lies bathed in the wondrous glory of the May-day sun. It is a very deep blue, like a lotus flower, bluer than the sky, across which milky little clouds are drifting. Close to you on the shore you see a double wreath of the young, golden-green spring reeds, no higher than grass, and then the brown wave of last year's withered reeds, with here and there a single tall dry flag crackling and waving above it. The giant surface of the sea really seems as small as a flower to-day in its hard blue. Over there, a long, hard yellow strip of sandy shore is drawn firmly on the blue as with a ruler, and above it, just as sharply drawn, is an almost black band of pine forest, dark and forbidding despite the garish sunlight. A delicate little rusty red cloud of budding alders on the sandy bank hovers in front of it, or a pale green spot, hazy as smoke, where a willow has already sprouted little leaves. The red factory buildings of the waterworks at the end of the woods seem to be made of children's building blocks, and their chimneys make long, reddish quivering reflections in the blue of the water.

The sacred stillness of spring is all around us.

And yet, now there is a soft tone, merry and afar, like a silvery little bell. Quack! Quack! Now here, now there, answering. Do you see those dots on the lake? Your eyes slowly get accustomed to the metallic blue and can tell them apart. Here are two larger ones, quite nearby. They are coming directly out of the shrivelled reeds and steering straight for the open surface. They are black, bald coots, and their white bills flash. It is their love-time. They are coming out of the reeds strictly pair by pair, and going blissfully out into the great blueness on which the sun dances.

This springtime sea is an endless snug bridal bed for countless little birds.

You only see the stragglers getting started, for out there the surface of the lake is swarming with pairs of lovers. Look at the endless chain of dots, with a huge mass of wild geese fishing in a closed column among them. A boat flushes them for a moment, and they

shade off toward both sides of the lake like a whirling column of smoke, and despite the distance, the soft rattling noise of their cackling voices reaches you, like the rattling of coffee cups in a restaurant.

Then all is quiet again.

Something flashes white at the rim of reeds, as if water-lilies had separated there and were slowly drifting off. But there are no water-lilies at this time. A new squadron of birds is following the coots; bigger fellows, with white breasts and reddish flanks, the head held up stiffly like the head of a hissing viper, wearing something like a little hood tied under the chin with a bow. This is the stiff feathery ruff which identifies the big hooded grebe, the king of all aquatic birds here, both as to beauty and proud carriage. To-day is wedding day for the hooded grebes as well. Look at that couple over there, side by side, very close together; two loyal exponents of marriage who mean business. "Kworr," "Kworr," their voice sounds somewhat rough. Sometimes they both raise themselves, kworring at the same time, out of the flood, almost to their full height, with their white bellies pressed closely together: it is their sweetest attitude of love. A second pair is approaching. But that is not a bridal couple. They are tattered bachelors, still pretty green around the bills, swanking around and looking to see if the month of May will not throw something feminine their way too. For the present, while engaged in the search, they keep together with the loyalty of tramps. Perhaps some honest wife can still be seduced. They take a chance, and come suspiciously close to that loving pair. Wow, how the lawful lord and master goes for them! First the one rival is hotly chased and then the other. Both of them are the objects of such energetic action that they dive under, head over heels. The female keeps quiet. It is the old story, as in the case of the spider and the cuttle-fish and even a bit higher up in nature. The stronger one will win; that is the logic of woman's loyalty. But the coast is clear again, and tenderly wife swims with husband toward the mirror of the open lake. Those nervy greenhorns have bobbed up again and gotten together, and after their rebuff they give that couple a wide berth and steer around them, out into the bright glare where they are lost to view, on new adventures bent, with a weaker husband.

Spring, love-life everywhere.

Close beside you on the shore there is a soft racket; not single sounds but one incessant murmuring tone, and likewise on account

of love. When it overflowed before spring came, the lake left a little pond behind here. Do you see the little white buds on its shallow, dark mirror? Those are the murmurers. Each one is the white throat of a toad, which sticks out of the water just that far. Now and again, a new one flashes to the rest, and there is a quick shift as when drops of water shoot together on a ledge. Then the row is set again and keeps on croaking in unison, always in an undertone. They are not just singing. Many of them, although motionless, are engaged in a jolly, secret love game; the males are embracing the females in the row from behind. It is all very cozy; an idyl of the little ones, for whom this little puddle is just exactly as good as the whole blue lake is for the birds. Wagtails see-saw like little elves around the puddle, naturally in love too, and in the woods an amorous green woodpecker gives noisy vent to his joy.

And the sun shines down and down, and shines into all this love; a stream of light and warmth from distant worlds, releasing a stream of love on this old planet earth. Each of these rays of light which flash on the little toad puddle wandered more than ninety million miles through icy space. And now it releases the love of these birds and toads like a glowing, intoxicating universal bath. Thousands and thousands of young birds and toads, newly procreated, will climb out of the light bath of a sunny day like to-day; one little soul to every mile of light, which will rejoice in this light. . . .

The wreath of reeds opens into a discreet, delightful spot for bathing. In summer, when the green reeds stand up like a wall, many a small boat, skilfully steered through the reedy labyrinth, was laid alongside here in the warm hour of dawn and showed human pairs of lovers a shore of the blessed, which no profane eye can see from the lake. Toward the land side, the red-columned temple of the pine woods, whose roots thrust like garlands out of the yellow cataract of sand, covers it like a second protective wall. The side toward the reeds is still open now. The water nestles softly against the sand which gleams in its own sun bath. The deep water of the lake, no doubt, is still springily cold. But the surface is already warm. There is a force of rejuvenation in such spring water for you as well. Strip off your clothes and dive in. You, with your white body, are yourself a silver blossom in the blue Walpurgis lake, like the snowy breasts of the hooded grebes and the little toads' singing little throats.

But now I have you where I want to have you.
Your naked body is the beggar on that fairy-tale bridge.
The sage who is to instruct you.
Your wise body!

"There is more intelligence in your body than in your highest wisdom." So says Nietzsche. I do not know whether Nietzsche was thinking the same thing that I am, or something like it. But his saying hits the mark and expresses exactly what I mean. Did you ever in your life seriously stop to reflect how many things your body knows more about than your clear, conscious intellect?

Your mind may rule over endless realms round about you. Suppose there is a king, whose will disposes over millions, whose word gives away whole realms and makes world history. And suppose this king would not know how to make his own heart beat, if his heart did not do it of its own accord. Like Sancho Panza he would wretchedly starve to death right at the epicurean board groaning with capon and lobster salad, if his digestive apparatus did not know exactly how all these good things were actually to be incorporated in the body. This idea sounds trivial enough, but its far-reaching consequences are immeasurable.

Your naked, white body, as it lies here in the young grass and lets itself be warmed through by the golden sun, does not look hoary with age.

It is rather your spirit with its brooding, which strikes you as being a bit grey already. And yet the exact reverse is the case.

Your individual conscious mind is in truth only a couple of years old. It stands there solitary, young, fresh, naïve. It bobbed up suddenly, like a blank sheet of paper. A few things have undoubtedly been written on the sheet by this time; the experiences of a couple of years, some history you learned, which gives you a small horizon and extends it further back of you. But at bottom your mind is still a youth, even a child. Perhaps that is the secret of our human consciousness of the "ego" and of our growing individuality; namely that the spirit is ever born again naïve and free like this blank sheet of paper, born as the eternal child of the universe. Perhaps the white surface of this blank sheet of paper is evolution's true surface, which must always be blank again in the entire organism called man, in order that something really new may be imprinted on it. In any case, your body is old as the hills compared

with your intellect. It is a hoary saint, in whom the recollection of all that is most primeval has never died.

Just think of all that your body had achieved before even the first, tiniest new letters of your own recollection were written down on that blank field of consciousness. Your body was built in your mother's body. The most marvellous performances were necessary to do so. First, the two corner-stones of your building had to come together there: the sperm-cell and the ovum-cell. Originally they had been divided between two human beings: the sperm-cell was with your father, and the ovum-cell with your mother. And so they first had to play a rôle there, each of them for itself By means of highly mysterious but absolutely existent actions and effects, they had to produce in both bodies what we call sexual excitement. Their actual union took place in the moment of supreme climax, when those two bodies gave themselves up exclusively to that excitement, in other words, when literally, as a united whole, they temporarily entered the service and placed themselves at the disposal of the will of those two procreative cells. Once they were both in the same body, the mother's body, the two cells performed that complicated play of their more intimate love alliance and fusion, which I told you about before. Only then did they proceed to form your body, by means of a sort of multiplication of their own, but of a non-sexual sort; by making ever new cells and more new cells come out of themselves. These cells arranged themselves in such a way that something like a general outline of your body developed at first, and then one room after another, one corridor after another, one staircase after another.

Imagine that the greatest conscious genius of mankind, Spinoza or Goethe or Darwin, it is immaterial whom you choose, were given the task of piecing together a crude heap of cells in such a way that a human body would result. It is impossible. Even the cleverest anatomist to-day could not begin to do it.

And yet these little building parts of the body, the cells in the womb, as a matter of fact must have known how to do the job. They knew without the slightest doubt how to construct a kidney, a spinal cord, a liver, so that it will continue for years afterward to perform its service under a system of division of labour, whose complexity makes the beholder dizzy.

These building cells of the body must not merely know directly and at first hand how a human being must be made to the last

microscopic detail. You will recall that extremely strange law, which appears to play a particular rôle in the construction of your body in the womb; the fundamental biogenetic law, according to which the germ or embryo in the womb does not immediately assume human form but first shows certain simpler forms reminiscent of certain definite animals, which we suspect were the ancestors of man in Darwin's sense during that old historical development. Thus, one stage of the embryo corresponds to the worm, another stage has gill-slits like a fish, and there are all manner of other strange doings.

Here an even more complicated knowledge on the part of your building cells begins.

They know about things which date back to the primordial world, which in part are many millions of years older than all mankind. They know that "man" was once in an animal which wore a long tail behind, or in an animal which lived in water and breathed with gills; or in one which carried a thin, gristly rod in its back instead of a firm spinal column. Your cells clearly know all of that still and so perfectly well that in building you they still take it into account and arrange their ground-plan in such a way that all manner of the old stuff becomes visible first before the real thing in the way of a human being emerges. They remember things which would never in the world have occurred to a world philosopher like Spinoza or Kant in all the years of their life as thinkers, and of which, as a matter of fact, neither Spinoza nor Kant had the least little inkling in their time.

Perhaps you will take umbrage again at expressions like "knowing" or "remembering." You do not want to grant the cells of your body anything of the kind. Everything is supposed to take place like a simple printing process according to definite natural laws, purely mechanically. But there is a funny thing about these words.

You can have any notion you please about soul and mechanism. It simply cannot be denied that in every cell of your body, whether it happens to be in your liver or your intestines or your sexual parts, there is a something which one must characterize as "of the soul." Despite all the cheap scoffing on the part of those who are not participating in doing any thinking, the concept of a cell soul (which we spoke about once before) is not a fairy tale but a very keen conclusion of thought. There must be something of the kind. Every cell has its individuality, and this, taken in itself, appears as its soul. And when I now see such cells constructing a building, the

body of a child in the mother's womb, with a consistency that could not be improved on by any band of human builders and artisans in transforming an architect's plans into concrete reality, there is, in my humble opinion, not the slightest thing to prevent us from saying, with regard to those cell souls: every one of these cells knows what it has to do. And when in the course of this performances occur in the sense of the fundamental biogenetic law which entail a repetition of things that happened millions of years ago, why, I can likewise only say, the cells remember. For the present, no human being can see into the innermost core of these things. Theories begin there. One man likes this theory better and another prefers that one. The only traditional usage is that each theory brands the other as "unscientific," although a sense of justice would have to say that in a field so full of vague hypotheses and purely provisional auxiliary constructions, such as the border zone of biology and psychology represents, the true postulates of a strict "science" do not exist at all as yet, and therefore are not given for any party to the controversy. Mechanism and soul, those are all just groping words which stretch out like the feelers of snails into the great unknown. The materialist will tell you the sum-total of knowledge and recollection in our human consciousness, as you have it in the form of your individual "spirit" or "mind," goes back to mechanical elements and principles. But in that case there would no longer be any fixed boundary in being at all. The extreme champion of the soul from his side of the fence will likewise reduce this boundary to vagueness and make it fade away by considering everything mechanical as being soul too, but soul excessively deepened. Even on these general grounds it would be hard to refute a person who might come along and whimsically say about the earth, for instance, that since it attracts the moon with its ten thousand trillion tons of weight, the earth "knows" how one does the job of shackling the moon to one's self. Knowledge in this case would be merely the expression in terms of soul for the selfsame performance which is expressed mechanically in that figure as the law of gravitation. Nota bene, expressed by us human beings, who in any case first produce all of these concepts "in a soul way," mentally or spiritually in the traditional sense, in order to have a go at these things with some sort of an auxiliary construction. As a matter of fact, in the case of animated cells the analogies to every phase of our brain activity (and the brain consists physically only of cells too!) become so obtrusive that the very sanest

and most cautious person must see in the end that (no matter what his fundamental philosophical standpoint in every sense of the word may be) things begin to jibe here and that therefore words no longer make any difference.

But let us limit ourselves to saying this: anyhow, the cells in your body do all manner of things which you, with your conventionally so-called mind or spirit up there, would absolutely not have known how to do or been able to do. If we choose to characterize that in terms of soul as knowing and remembering on the part of these cells, it is in any case a knowing and remembering which for the present has no connection with your whole intellect up there. And that is merely what it is supposed to express when I say: your body is wiser than you in these definite points.

Let us pursue the facts a bit further and in so doing keep strictly to the line of love matters in the narrower sense.

Love is a ghost which haunts your spirit and builds heavens and hells there. But now come to your wise body. What would you be without it when you reach the years of love! Just think that over—without prudery, which has no business anywhere among these sacred things, but in sober seriousness.

In its time of coming to maturity, your body "knows" all about sexual functions perfectly well, be your conscious mind a never-so-blank sheet of paper in this respect.

Assume that as a sexually immature child you were cast away on that rock, cut off from all the world, which Chamisso's poem celebrates: Salas y Gomez. All alone. Not another human being there, outside of this poor shipwrecked child. Nothing but blue sea round about, and sea-birds on the cliff laying eggs. Let the child's instinct of preservation be just sufficiently developed for it to be able to drink rain water out of a hollow in the rock and live on eggs. Now let this Robinson get on in years. When it is a man, it has never heard a thing about the mystery of woman. Nor conversely, as a woman, has it ever heard of the mystery of the male. The conscious state of its mind is absolutely clean and void on this score. Nobody is there to write on it. And yet, on that lonely island of the ocean, there is one that knows about matters of love: its body.

The body knows about love, even if not from spoken or written words or from seeing. It knows about it by virtue of a primevally old dark tradition that travelled the direct road through the evolutionary bodies of the sexes. Its cells, which once arranged them-

selves to form this body in the womb and in the course of this ordering process laid down the sexual parts as well, long, long before there could be any thought of making any possible use of these parts, know a whole lot more about how and where this road runs to.

If the solitary child is a girl, at a certain period of the ripening process, say about the fourteenth year, according to conditions prevailing among us, there takes place for the first time an internal act which has absolutely nothing to do with the girl's own consciousness at all, but which strikes it as something coming from a strange world. That gateway of the body which until now had served only for passing urine suddenly discharges blood. This discharge of blood, however, has a very deep connection with an internal sexual activity of the body, which is merely indicated by it as an external sign.

A little fruit capsule on one of the two ovaries had burst, clearing the line for a diminutive human egg. This ovum was then slowly transported through the connecting canal to the womb. There the mucous membrane which tapestries the interior set up a sort of inflammation, and the upshot of this inflammation was that discharge of blood which finally became visible as it ran through the external gateway.

This whole separation process and internal journey of the ovum is an active sexual deed on the part of the body. It "knows," to employ that little word once more, that the spermatozoa, coming from outside, will advance toward the womb. It knows that the womb is the best place for the development of the impregnated ovum to take place in. It knows that fertilization is not possible in the closed little bladder on the ovary (the so-called follicle), in which the ovum lies at first. Hence this business of going to meet the other halfway. If the girl is really a hermit, all the friendly advances in the world will as a matter of fact prove in vain. The sperm-cells will not show up, even if an expectant cell wanders into the womb to meet them month after month. But even so, what a whole lot of wisdom those cells deep in the sexual apparatus in there have, compared to all that this whole girl knows, who neither knows what this monthly effusion of blood signifies nor will ever of her own accord, mentally, during her hermit's existence even hit upon what the difference between a man and a woman consists in and what can constitute a sexual act! Why, as regards that bleeding, we have under conditions as they exist among us and which certainly have nothing in common with Salas y Gomez, thousands and thousands of

girls and women who never in their whole life informed themselves as to what this phenomenon was all about. They think it is just a nasty chance gift, which fate has tied to the noble concept "woman." And they never suspect how, with this very process, they are far surpassed by the wisdom of the body, without which the human race would long ago have wretchedly died out. This red wave is indeed a a wave of life for mankind.

Now take the converse case. The case of an equally solitary boy who becomes a man. The difference between the sexes remained completely unknown to him mentally. As regards the whole of sexual life, the free field of his consciousness actually remained completely blank and void. He has not the slightest inkling that beings could exist whose bodily apparatus might be constructed differently from his own in a certain definite respect. No matter how much he might brood, he will never be able out of his own thinking to evolve a picture of the physical structure of a woman. He does not even know that there are two different kinds of beings in this sense. The cells of his body, when they proceeded to tailor him to the measure of a "man," went about it in first line by arranging themselves in such a way that the typical human male organ developed in his case. This male organ would have been utterly senseless if it had not been exactly suitable to the facts of the case. As in the case of the female, this organ simultaneously formed the body's exit gateway for urine, for the waste products of nutrition, which simply have to be removed. From this performance of removing urine not the slightest reason could be deduced why in that case there should not be a simple gateway in the body, exactly like the female one for the same purpose. But when, instead of that, the constructive cells already laid down a male member of the universally known form in the child, they were simply looking ahead and taking into account, not the act of eliminating urine, but the sexual act. They set up an organ, whose complement was the female vagina; one which did not correspond to the latter in the sense of having the same appearance, but just the very opposite, by its very difference which was in truth an extremely useful, logical supplement to it, however. The constructive cells which gave this organ the shape of a projecting, wedgelike body, unambiguously builded with a view to a second organ in another human body, which would represent purely an opening, into which this wedge-shaped body would fit.

The "wise body" knows all about some other things too. The mere existence of a male organ which somehow or other projects externally is not enough for the actual complementary purposes of sex. This organ must get set right, in a certain mathematical way, in order to be able to fulfil its great and sacred purpose. Let us imagine the body of a man and the body of a woman turned toward one another. Mathematically, they form two parallel lines which according to a simple theorem of mathematics can never intersect. If I want to establish a connection between them, which at the same time shall be the shortest one thinkable, I must drop a perpendicular from one point on the one straight line to the other parallel line. The position of this perpendicular is now undoubtedly the only situation of that organ which answers its purpose. The "wise body" sizes that up perfectly. As soon as the years of maturity begin, the same when in the case of the woman that mysterious wandering of the ovum-cells started, it immediately makes certain congestions of the blood take place in the male organ on slight stimulations. This congestion of blood fills the cell tissues of the external organ with large quantities of blood, which cannot flow off right away. The result is that the organ in question swells up in such a way that its wedge-shaped body is now actually set at right angles to the straight line of the whole body. In this imaginary case, our hermit naturally lacks the concrete parallel, a woman, just as previously was the case with the female hermit whose wandering ovum-cell caused the bleeding. But just the same, the conditions are fulfilled on the side of the man, at least in the sense of a "knowledge" of the entire course of events; and that in the case of a maturing youth who mentally, spiritually, does not know what a woman is at all, let alone knowing anything about the mathematics of the act of copulation.

You can spin these trains of thought out a long way further and they will always give you the same result. Think of the act of procreation itself; and how it is not your conscious mind and the will of your spirit which brings the spermatozoa actually into action at the most decisive moment, but your body, on its own initiative. Recall how the female womb now prepares the little hidden crib for the growing little embryo in a long series of most ingenious and artful acts, how it will be fed indirectly by the mother's blood and how finally, at the proper time, the body will release it by the pressing pain of labour, all alone and all without asking the mother's

consciousness for advice or permission. Only from the body did the mothers of early times learn the fact, and then pass it on by tradition, that it takes about nine months for the human infant to come into existence in the mother's womb: of themselves, they would certainly never have known that. The mother experiences yet another piece of "knowledge" on the part of the body, when that delicious, nutritive liquid food, the milk, suddenly comes from her breasts. This white, warm "soup" as well as the natural bowl in which it is served are very exactly made for a small new being which, very contrariwise to all mature full-grown humans, has not a single tooth in its mouth as yet, and is therefore dependent on sucking fluids. A poor young human mother in the wilderness, who were to grow up with no instruction whatever and who had never seen a child until she herself gave life to one as an ignorant Eve; how should she with her consciousness ever have hit upon the idea before that this little dwarf of her lap as yet possessed absolutely not a trace of that shining set of teeth, which she as a child of Nature has called her own for as long as she can remember! This memory of hers has the fatal rift just there where her own life history switches over into earliest childhood, and it will hardly tell her that she too was once without teeth and lay on a warm maternal bosom and sucked.

The climax of the marvellous thing about this case is that even your man's body (and that completely without any connivance on the part of your consciousness) possesses a dark knowledge of the apparatus for the toothless suckling. Run your hand over your naked breast. What do you feel? An elevation at the right and at the left; a nipple. It corresponds to the little suction stopper on every female breast, which baby so well knows how to use when the "feeding bottle" is full. In olden days and in more recent and critically cautious times, isolated cases have again and again been observed where a man possessed not only the nipples but the actual milk apparatus in full activity and could nurse his child. Those are manifestly rare exceptions instead of being the rule. But in any event, the male nipples are there, like secret knowledge, a mysterious self-recollection on the part of the male body of those needs of the newborn, even though it may be knowledge and remembering which has become useless for ordinary purposes. Let our hermit boy on Salas y Gomez, who never has learned of the existence of women and children with his consciousness, become as wise as Solo-

mon: and how should he ever come to understand the dark knowledge and significance of his own body in the matter of his own nipples which he has right under his very eyes every day of the year?

These illustrations will be enough, since they all lead to the same thing in the end. I think that you now have an inkling what a sage lies before you there in the vegetation of the shore—an adept, one that knows, and can really teach you like a child.

It has taken long enough for the naked body to come into its own as a teacher. How has mankind tormented itself in its thoughts to get away from it as far as possible! It was concealed as if it were an abomination. The flesh and the devil have been positively synonymous ideas for a long while. The anchorite wrapped himself up to the chin in camel's hair and stared at the stars as if he were staring at anything else up there than just a body, at the giant structure of a body of fixed stars and Milky Ways, which has its wisdom like his own body; which gives birth to suns as his does to spermatozoa. . . .

As long as the poor body was treated so badly, it kept defiantly silent. If it is to answer our questions, a certain cleanness in us, the interrogators, is necessary. We must accustom ourselves to look at the naked human body as calmly and without prejudice as at a beautiful flower, which, to be sure, does not come easy by any means as yet. We are most likely to succeed in bringing that about in the sense in which the doctor looks at a naked body. Compassion makes everything chaste for us. But that still is not enough. We do not look at a flower with compassion, but we rejoice in it, when it is in the fulness of its health and vigour.

And yet (a veritable hint from Nature), not only the naked body, but the most dangerous part of the body which could be selected, the sexual part, is just such a flower in the strictest sense.

There is absolutely nothing that can be done about that. The fiery red rose and the silvery lily of the valley, the chaste lily and the burning poppy, they all are big, obtrusive sexual parts. The pistil is the female organ awaiting fecundation; the stamen is the male member from which the semen drops. All the gay colours, the perfume and the honey are means of alluring flies, bees and butterflies, which mediate copulation by flying back and forth.

Take this little forget-me-not which has just unfolded out of its

little violet bud. It looks at you like a dear girl's face, fresh as dew, a dwarf girl on a green stem, by some sorcery. And yet it is not a face; you are mistaken. It is the little plant elf's lap of love. It is the most precious, most sacred part of the entire green plant body. And this little body is a knowing one too: without the least fear, with a clear recognition of its mission, it stretches this most important organ the most openly of all into the sunlight. The blue of the soft elfin skin is to attract insects, so that they will play love's messengers. The little yellow wreath which twinkles so prettily in the blue star has an effect on the insect like the trusty sign of a favourite inn: here there is honey on tap. As the insect pilfers honey, it carries pollen onto the pistil of a neighbouring plant. It is all nothing but sexual parts and sexual affairs. Every flower-bed which is a riot of colours is just one grand advertisement extolling countless sexual organs. The little white myrtle stars which you wind into the bride's hair are sexual parts. The carnation, red as sealing wax, which you sport in your buttonhole, is a sexual organ. The pussy-willows, dropping golden dust, which you place in a glass as the first dear harbingers of spring, are male sexual organs: the sexes are separated in the case of these hazels; the catkin of the hazel is merely the male blossom; but on the same twig you will also find tiny, red, feathery blossoms peeking out of the tips of little brown leafy buds; and those are the female parts, which longingly will suck up the golden vital dust of those others and in that way copulate.

And yet, if you tell yourself all that, what does it change for you at bottom about the beauty, the cleanness, the loveliness of these gay floral children, over which innocent eyes will rejoice as long as the sun warms this joyous planet and cooks colours and perfumes in living plant cells. I believe they will be just as dear if not dearer to you than before. The only difference is that you have now gained a more intimate relation to what they really want and are helping to do in the world. You have found a key to a new, fuller story about its dear face from the moment that you know that this little forget-me-not or myrtle star is blabbing the love-story of the plant.

It must be possible to achieve such a floral standpoint for your body too. The moment you have it firmly, your body will begin to tell you tales in a totally new fashion. In its case, too, its most wonderful story starts with the sexual parts, with its flower.

§ 5

Well, then, what is man? Your sage gives you a very simple but convincing answer.

You are on earth and the stars are above you. In the widest sense, you are a cosmic body as they are. Size matters nothing. A solitary little splinter of a meteor in space is much smaller than you, and yet you cannot characterize it as anything else.

Your body's real fundamental knowledge consists of general properties of cosmic bodies. Your eye seizes the star Sirius' little dot of light in the universe. Sirius is many billions of miles distant from you. How does it happen that you can touch it with your body after all? You and Sirius both of you swim in the fine cosmic substance which the physicist calls the ether, like two fish in the same vast pond. The colossal flame of yonder glowing Sirius strikes curious circles of waves in this ether. You know the circles that arise in an ordinary pond of water when a stone is thrown in; always one circle around the next one, in the course of which ever new particles of water become involved, ever more distant particles of water until finally the outermost circle breaks against the shore. That is the way Sirius too generates strange, probably electro-magnetic waves in the light ether, and as these circles of waves traverse those billions of miles of the intermediate ether body to you and are caught up by your body, you get the phenomenon of light. You "see" Sirius. This can only happen, however, because you are a cosmic body in this great ocean of ether exactly as Sirius is.

In the same way you receive light and heat from the sun, although it is some ninety odd million miles away from you. Your body knows very specifically what this sunlight is all about. As it lies there, white as a flower petal in the green vegetation, it produces this, its colour out of sunlight by its own performance. Its skin reflects the light and appears "white" in that way. At some spots it picks merely a single colour out of the sunlight (which, as is well known, contains all colours in its white as a mixture) and this colour it paints on alone: and so your lips give back only red. Conversely, your black hair swallows almost all the light, and the

cornea of your eye, which has a purpose in letting all the rays pass through into the interior of the eye unhindered to the greatest possible extent, neither reflects nor swallows any light, but lets it all straight through and therefore appears absolutely transparent.

As far as the universe which is known to us reaches, you are connected with it through these ether things; even to the farthest nebula. You would not know of this nebula's existence if your body did not know how to parry its light waves and bring them into your possession. Numerous other things, with which your body constantly is concerned, take place with this same ether. Those much bigger waves, which we call electrical in a narrower sense, come along and pass through your body now this way and now that. Who knows, at this very moment when the voluptuously soft, indescribable magic of the spring sun and the spring air thrill through you so that you quiver in every last fibre of your whole being, who knows what ebbs and flows through you in the way of all manner of such and related and even totally unknown and unnamed undulations of the cosmic ether, undulations which are stimulated at unknown central suns, reflected and reinforced by suns and again refracted and transformed by planets in special situations in space and with special positions of their axes?

Your body has still other capabilities of cosmic bodies. It is part and parcel of the universal net of weight, of gravitation. Just jump down from a certain height. You do not need to want or think or do a thing: your body "knows" the mathematically exact way all by itself. Galileo and Newton were the first to expound something about the law of falling bodies and gravity generally to conscious human spirits tied together by written tradition. And yet the bodies of human beings have been falling according to the most cunning consequences of these laws as long as there have been human beings. Empedocles fell into Ætna according to them; Marcus Curtius breezed into the famous crack in the earth at Rome; Fiesco stumbled from his world historical plank into the Black Sea. And the decisive thing about it all has always been that the little human body has a certain mass and the enormous body of the earth so much mass, and that the smaller mass purely automatically is pushed against the larger mass as if by reason of a primordial lesson which has been drummed into it, according to the formula determined by Newton about the "direct ratio of the masses and the inverse square of their distance from one another."

In this sense, you as an individual human being are as ā matter of fact nothing else but a small cosmic corpuscle, which happens to be a diminutive satellite, a small lean moon, as it were, of this colossal fat body of the earth, by virtue of the force of gravity. It does not whizz around the earth high up in the ether with the speed of that other big moon, kept in dizzy equilibrium by its own impetus.

With small motions it very slowly crawls along and close to the hard crust of the earth, and it was only not quite four hundred years ago that some of these moonlets succeeded amid great perils and constantly sticking close to the old native earth and water in "circumnavigating" and getting around the entire belly of the planet as the big moon does it for us high up in the open ether once every month as a promenade which is a matter of course. For something over a hundred years it has known how to increase its eminence just a bit by ballooning. When a Zeppelin sooner or later flies around the earth, the similarity will be carried a bit further.

This general doctrine, by virtue of which your body makes itself known to you as a cosmic body among nebulæ, suns and moons, is all very interesting. But the body immediately specializes a good bit nearer home.

The cosmic globule which you represent quite unmistakably takes a definite place in a certain sequence of creations from cosmic substances. Your body was already constructed of very specific substances in the womb, and it constantly replaces itself by means of similar substances. This choice of matter gives you your rank in that series. You are not a genuine nebula, which consists merely of two or three substances, principally hydrogen, in the very loosest gaseous form. Compared to a nebula, you are already very much closer to the sun. The sun consists of a certain number of neatly separated elements—a whole table full. But this sun still lacks a whole lot in order to put your body entirely on its feet. The substances in the sun are all of them in a frightful state of incandescence; on the inside of it is a uniformly white-hot shell or at least something constructed materially similar to one, and gay veils of metallic vapours wave around this white-heat. The heat is so tremendous that permanent chemical combinations between the several elements are still entirely out of the question, as it seems. But such combinations constitute the true building materials of your body, with which it works practically exclusively.

You have only to recall the simplest of all such combinations, the

famous H_2O, as the chemist says; two parts of hydrogen and one part of oxygen united to fill the prescription calling for "water." What would your body do without water? It is not only one of its most important food-stuffs, but constitutes the bulk of the building. All the solid matter in us is one grand Venice, washed round by water, floating on water. The newborn child is sixty-six per cent water; the adult is still fifty-eight per cent. Even your solid bones contain twelve per cent of water, your thinking brain seventy-five per cent, and your blood all of eighty-three per cent. But in the whole solar globe with its diameter of over eight hundred thousand miles there is not the smallest spot where even a single drop of water could exist. Well, then, you are no sun, either. You belong a cosmic step further, in the region of things which are already a whole lot more cooled down, in the region of planets.

Where the temperature goes down to a certain comfortable moderateness, where iron hardens and on its hard outer crust begins to start a chemical flirtation with oxygen, so that a red crust of rust develops; where the wild spirits of the air, hydrogen and oxygen, likewise copulate in love and all at once stretch a blue bow of sky over the open country as their wonderful water baby, which is fresh as dew, and from which drops of water descend, which unite down below to form social co-operative associations, springs, lakes, oceans, there first is man, the most mysterious of all known cosmic bodies, at home.

But again he has his special place on the planet earth. Let the wings of imagination carry you out onto the lonely, sunny blue ocean. Volcanic forces burrowed in the depths of its bottom. For a while, the water cooked and boiled up frothing white at a certain spot, a column of steam stood above it like a danger signal, masses of pumice-stone floated off in all directions in wide fields like foam turned to glass. Then suddenly, one morning when the steam dissolves for the first time, it is there; a black rock which towers above the flood and breaks the long waves of the ocean into white foam. As the result of some shift of masses, a fissure had formed in the earth's crust. Substances of the rocky deep were abruptly discharged; they gushed upward, burst through the deep-sea ooze and piled on top of one another in the water, hissing, higher and higher, right up to the mirror of the sea, and at the same time they cooled off in the flood and became rigid . . . a new island is there. Naked and that is all for the present. God does not put in an appearance

to create anything on it. But Nature which is already on hand will help out, even if it takes some time.

Very gradually the phenomenon of the planet earth, which in our common usage we call "life," appears on that small piece of rock.

Those ubiquitous invisible beings, the bacteria, are wafted here by a breath of air. They, that live in the burning tropics as at Nansen's Farthest North; these unpretentious creatures that could have flourished on the nakedest rock of the primeval earth which not a speck of vegetable mould yet covered; they, that can breathe hydrogen sulphide if it is necessary, that are a poison and an abomination to all else living, and that literally eat stones for bread. Further there comes with the wave the mussel shell, swept on land; the clumsy turtle comes, and lays its eggs here; seals come rolling their unbutchered bodies up, in order to fight out their amorous adventures in the hidden stillness of this strand. Shrieking sea birds, which powder the peak of the rock with guano as with snow, come by air, and a small beetle, blown off its course by the wind, turns up and hastily digs in the dung and lays its eggs. A storm roars and passes in the night, and when morning comes, it has luckily succeeded in shipping over a cocoanut on its white horses from the neighbouring coral island, far below the horizon. Its solid construction protected it from the ravages of the salt water. And now that strange organic being, which we call plant, directly arises here, with a root bored down into the kingdom of earth, with a stem oriented upright toward the light; and a bunch of green leaves waves to and fro on this stem, drinking in the sunlight; and as they drink, they digest the parts of the air which are unfit for animal consumption, like heavenly manna which each blessed day gives them anew.

And there you now have all the great kingdoms of terrestrial Nature together. Here the mineral kingdom, the rock set in its wave; and there social life. And this life again is divided into bacterium, vegetable and animal. Where do you belong, if you mentally put yourself on this nice brand-new creation of an island? Your body answers at once, and unambiguously.

Compared to the swirling incandescent sun up there, you belong with the congealed lava rock and the cool blue wave. But on this rock you are subject to another sharp division and you belong to those formations of so-called animate Nature. Your body possesses a certain wisdom which that block of lava in the ocean would never

have; it is the special wisdom and experience of the organic-living. But as this in turn divides in three different roads, you are once more subjected to a more limited choice.

Compared to the rock and the wave, you certainly belong more closely with the bacterium. But the bacterium as the simplest living being consists only of a single little lump of living substance; a single so-called cell. Your body is like a proud kingdom of such cells. It is true that it started once with only two cells; a sperm-cell and an ovum-cell. Yes, and they fused and then there was just a single cell left. But this cell then increased and multiplied, as if it had been deposited in a fairy-tale bank at usurious compound interest: billions of cells to-day compose your finished body. As you lie there in the grass, you have about ten pounds of blood alone in your body. Little red globules, the so-called corpuscles, circle round in your blood. Each one represents a cell (even though a subsequently somewhat changed cell, robbed of its nucleus.) Those ten pounds of blood contain approximately twenty-five billion red corpuscles, each one equal to an entire individual bacterium in value. You are far, far beyond the bacterium, that is all there is to it; you are a Milky Way of the living compared to the splinter of a meteorite. That is the very thing which brings you together with plant and animal. The palm-tree too consists of so many cells that it would make you dizzy to try and count them. And the oyster, the turtle, the bird, the seal are each and every one a pyramid of cells of a similar sort. Your great cell master builder, the body, teaches you therefore that you are either animal or plant; not a one-celled bacterium. But what about it again: animal or plant?

For your fledgling intellect that might prove to be an honest-to-goodness disputatious doctorial question, worthy of the sweat of philosophers. But your body decides instantaneously. Here again it has had an old lesson drummed into it at school and settles the matter, with or in spite of all your philosophy. And this lesson put into words simply means: I am not a plant but an animal. Your chest gently rises and falls under your nipples, under your breasts, about which we spoke before. You breathe. The cells of your body form a double sack, the lungs, down below there. They take up oxygen into the blood, and exhale the useless, harmful carbonic acid. Somewhat deeper down in your body the cells form another sack with a number of sausagelike dependencies extending way down and way back: they are the stomach and intestines. Here you daily

cram in a certain amount of vegetable matter or different animal matter and you work it up in the same way, keeping one part and eliminating the other part. But that is decidedly the animal way. At least, plants breathing with the green surfaces of their leaves during daylight exhale the very thing that animals retain when they breathe; that is carbonic acid. At least, plants as a rule by no means live on other vegetable substances or animal substances, but directly on inorganic matter, which you absolutely could not use. So you are an animal; no doubt about that. Your body has been trained to do its tricks in the household of its cells as an "animal"; and it just does not know how to perform as a "plant." Its wisdom is animal wisdom; it therefore has no further choice whatever about that question, as soon as you want to listen to it at all.

§ 6

Like the penny in the counting machine, you are already sifted along one rubric further. And now, what sort of an animal are you? In our foregoing illustrations we already had mussel, turtle and bird. There are several hundred thousand (living and extinct) kinds of animals. Take Noah's ark. Where does Noah himself belong? Your body is not a loose lump, just a first loose association of cells which feed in animal fashion. These cells are already arranged in the most ingenious manner according to the great principle of division of labour. They form organs, each of which represents its own special department in the general household of your body. These organs, stomach, heart, lungs, the sexual apparatus and so on, are in turn miniature bodies within the big union body. You can read the rest of your elaborate proceedings to provide yourself with a rubric right off the bat from this organization of the body into organs.

The first to speak up is our old friend, the stomach.

It places you not merely by the general method of its choice of food as an animal; but still more closely by its marked form as an organ in the interior of your body, which (taken in the widest sense to include the whole of its intestinal extension) forms a long inner tube, into which food enters through an external hole in the wall of the body, the mouth. By virtue of this form it proclaims to you that you belong to a certain higher group in the animal scale. The very lowest animal tribe, which already feeds in animal fashion and in part already consists of many cells, entirely lacks a stomach as a definite internal organ with a definite mouth, as you know. You obviously do not belong to these original animals or pre-animals any more. But such an extremely simple little animal, relatively speaking, as that green fresh-water polyp about which I told you before already has a stomach and mouth. From the gastræa and approximately similar forms related to the gastræa, such as the hydra polyp, on upward in the classification, the entire animal race has a regular stomach and intestine, except in cases where some parasitic rough-

necks like our tapeworm subsequently got rid of it, because they could get on fine without it.

You therefore undoubtedly belong in this "upward." But that fact does not make you a gastræa or a hydra polyp any more.

A polyp like that has a somewhat complex skin on the outside and a simple stomach inside. Skin and stomach leave a hole on top; that is the mouth. You are not constructed as simply as that.

In the first place, your stomach itself points out something which is not there in their case. Your stomach does not just open through an upper extension, the gullet, into a mouth that takes in food. It likewise extends out behind through a certain number of tightly coiled intestinal continuations until it reaches a gateway at the opposite pole of your body. Everything in the way of superfluous remnants from the food taken in at the front end, which has to be got out of the body again, passes out here.

This counter-gateway is tremendously in disfavour according to our everyday notions. That surplus material and waste from the big digestive plant has branded on its forehead a kind of notice or warning that it has been dismissed for good without appeal as being "anti-human," by an inner jury of the human body. From primeval force of habit and protective adaptation, man's senses came to an agreement to impress the smell of this waste matter above all on themselves as being the smell of something utterly useless and worth avoiding. Our spirit receives that from the body as a matter which has been ascertained and settled long ago. And so it has taken over this smell and this concept as the highest sum-total of all that is abominable, nasty and disgusting. While it revels in the consumption of food with all its pleasures, it curses that converse corner to the limit. For it, a little word like "excrement" becomes an epithet for all that is lowest, all that is most unworthy of human beings, for all that is most loathsome and execrable, although in principle it is just a harmless chemical like all the rest after all. Hell begins where it smells of excrement. In itself, that is a very ingenious business, it is likewise one of the body's bits of utilitarian wisdom which are as old as the hills, which we young intellectual children had given to us right away to take along, even if it happened in a somewhat crude form. In the sense of a coarse form of utility, it was in any event highly profitable that the poor stupid children of evolution should have it drummed into them with as heavy a hand as possible that what passes off at your opposite pole is absolutely

useless stuff, it is the very same stuff that your cell body could not and cannot take up in itself, therefore, for goodness' sake do not eat it again, so that your stomach and intestines will not have love's labour lost all over again. When the senses finally had that really drummed into them by so and so many experiences of many generations, they quite consistently said "shame on it!" on seeing such matter. And the sense that reacted most directly to it, the nose, said: "It stinks." Lastly, the so-called intellect (meaning the upper story where the great connections are made by a higher individuality) came lagging behind and said: this matter of the posterior pole is "indecent"; one must kill it by keeping still about it, and not take it in the mouth any more even as speech or as an idea. Now that is all very well and good. But our unprejudiced way of looking at things, to which, in a still higher light of knowledge, the body is clean, as a sacred object of knowledge without resorting to any little practical means of petty utility, may and must let itself be instructed by the anus and its wisdom despite everything, just exactly as by the wisdom of the mouth.

And in this case it is by no means sham wisdom which the anus teaches you, but again it is a piece of knowledge which is right in our line. Imagine that you had grown fast somewhere with the posterior pole of your body from infancy. In this case it would be a bit of an impossibility for the anal gateway really to function. If your stomach and intestines wanted to get the indigestible waste out of the body, as it had to, there was no other way for it but to spit it up and out through the selfsame mouth that had swallowed the food down just in a general way and without finer selection. That would bring you back to the standpoint, which a large, more limited circle of higher animals possessing stomachs (we considered several of them before) really takes. They happen to be all those which are more closely connected with those hydra polyps. The hydra polyp itself on its behind and all its successors do the same. They live without an anus, and when they have digested enough material they spit everything that is indigestible out again in the same direction. You have animals like that in the many-shaped groups of corals, polyps and sea-anemones, and finally of the jelly-fish too. For even though the jelly-fish detaches itself from the polyp stadium and floats off in the water like a bell turned bottom side up, it nevertheless stays grown together behind like the bell-glass over the cheese. But you, as man, with your mouth and anus between which

the stomach or intestinal pipe forms a single tube open before and behind, you number yourself among a more limited animal group which is still loftier: in this respect you are not a coral nor a jelly-fish but a worm.

Beginning with a certain group, the worms already perfectly show the same fundamental tube form as you. And from there on this continues to be the case throughout the whole upper story of the animal races. But if we once have to get down to a choice between man and worm, several other organs of your body besides the anus come into consideration at this point. You prick your finger with a needle, and red blood gushes out. This blood streams through all the walls of your body's tube in splendid canals. It gives food and drink to the last little fibre of your being, like an inner fountain of life. When the blood runs out of you, you languish and perish wretchedly. If the wave of blood fails to wash out your brain for just an instant, you fall in a dead faint. This trick of the inner body's blood canalization turns up for the first time in the case of the worm; everything ranking below it knows not a thing about it.

And further. I said your brain becomes paralyzed when the blood fails to feed it. The brain too appears for the first time in the worm. It is true that you already find the clear beginnings of a nervous system among much lower animals. The gay little tiara jelly-fish, that sails over the blue ocean without blood, already wears a double ring of nervous substance on the rim of its transparent swimming bell; a "spirit ring," if you will, and there already are little eyes and ears on these jelly-fish rings, which undoubtedly grasp quite a bit of the outer world in a similar way to yours. As a big, sovereign lump of "spirit substance" your brain is crowded together and occupies a fixed place above the oral opening of your stomach tube. And that is just the way it first bobs up in the case of the worm. The worm too is no longer a bell like the polyp or the jelly-fish. At least in its more developed form, the worm already has the longish tube as you have. The worm's nervous substance is concentrated into a first real "brain" at the important forward end, on the watch over the food maw. You as man walk upright to-day, instead of wriggling around horizontally like the worm. You no longer crawl on your belly but balance yourself most ingeniously on the hind-legs placed under the tail-end of your body. But even so, you still have your splendid big human brain located at the oral end of your body tube, exactly as in the case of the worm.

§ 7

Meanwhile the sorting machine rattles you through the mill again. Your eating and breathing claimed you as an animal in opposition to the plant; your stomach and mouth as a higher animal, beyond the polyp, your anus, blood and brain as a very high animal, beyond the worm at the least.

Where do we go to now?

Only that limited series of extreme animal branches, among which we wandered back and forth so long, still rise above the worms in the classification: for instance, the starfish and their relations, the snails, mussels and cuttle-fish or the crayfish, spiders and insects. Do you belong anywhere in there? These races are all so fundamentally different, the one from the other, that you necessarily can belong only under a single rubric. The question is, which one.

Tap your forehead with your finger. It is man's favourite gesture when he wants to indicate that he is hopelessly stupid, and does not know what to do. But right here, where everything becomes intellectualized, even if you tapped the most impossible parts of your body, this gesture is the simple way to the answer.

Again your body answers your knock. What does your finger hit hard against? Not against your brain, directly under the white skin. In that case, you would just be back with the worm again: You have a hard wall between skin and brain there; the bony wall of the skull. Your delicate brain is enclosed in a capsule of solid shell. Stand up. There you stand in the glare of the sun, in all your naked human beauty. How does it happen that the soft tube of your body can carry this heavy bony capsule at its tip at all? Why do you not double up wretchedly with it?

This skull is only the crown of a whole bony skeleton in you, in which all parts support and carry one another as in a wonderful temple supported by columns. Here in the centre line of your back, between your shoulder blades and thence downward, the chief column of the temple, the spinal column, shows under the skin, just barely, gently indicated in soft ornamentation.

Your soft brain sends a sort of big tap-root down this same line.

The spinal column supports, surrounds and protects this tap-root of nerve substance, the spinal cord, just as the hard skull does the brain. If we are really to regard your soft body as a worm tube placed upright, then it is just as if a stiff board had been thrust beneath the rear wall of this tube in the spinal column; a board, which gives such firmness and support to the whole that now the tube almost appears merely as a covering and a soft bellying attachment of this board.

How this board is thrust into the tube is interesting in this connection. In the first place, it lies conspicuously at the back; the word "backbone" already takes that into account. The skin with the layer of muscles lying under it, in other words, the outermost wall of the tube, reaches entirely around it. The separate inner tube of the stomach and intestines, on the other hand, lies essentially free in front of it on the belly side. Brain and spinal cord, the tube's most important nervous masses, appear at first sight to have gotten into the board, so to speak. But if you look closer, you get the impression, particularly from the spinal column, that this board with its solid mass is actually shoved in in such a way that it lies exactly between this spinal cord and the stomach tube. And only from this basis did hard parts of the board (bony parts) then reach upward and around the soft brain and spinal cord parts, vertebra by vertebra and lastly in the case of the skull, so that finally these parts got into the topmost layer of the board as into an overlapping canal.

This grand internal back support of your body is now the immediate solution of the riddle, where you belong above the worm. In the animal branches beyond the worms, you find all manner of similar attempts to strengthen, support and protect the soft tube body of the worm somehow or other, by all manner of bony formations and hardening processes, by so and so many boards that are now turned in and now turned out. The snail has its house, the mussel its double shell, the sea-urchin its strange melon full of spikes, in which it is lodged as in a chestnut burr, the crayfish its splendid armour which externally follows the whole complicated body to the last little fold and joint. But all of that has not the slightest similarity to you and your backbone. None of these animal races affords you the slightest essential fact for believing that this, your "back" could belong here. If your belly with its stomach and intestines separated you from the original animal below the hydra polyps, your beautiful, proudly erect back, the joy of all artists since

the days of the old Greeks, now separates you from the mussel, snail and cuttle-fish, from starfish and sea-urchin, from crayfish, spider and beetle and butterfly. On the other hand, it just as surely points out a very definite line onward and upward above the worm to you now, as your line.

There is a curious race among the most highly developed wormlike animals. These are the so-called tunic animals or ascidia. They are aquatic animals; total strangers to the layman. In Naples they are eaten, to be sure. But what you get to eat there looks more like a rotten potato than an animal, and a relatively high one at that. The full-grown tunicate of this sort forms a woody bark around itself. It lies like a rotten egg inside of this, which likewise frequently serves as a breeding ground for all manner of other repulsive things, and that is what the Neapolitan plucks out as a titbit. But as a young animal, the said ascidian is not yet so wooden and set in its ways, and it swims merrily around as a crystal-clear wormlike creature with a long rowing tail like a tadpole. And in its happy active youth it affords an extremely singular picture, as regards your human back. Above, in the worm tube back, you see a brain with a prolongation as spinal cord. Underneath, in the worm tube belly, lies an intestine. A staff or spar composed of a mass of cartilage which anyhow is somewhat firm is shoved between the two (exactly at the critical place where the hard board was shoved in in your case, a short distance from the tail and thence on ahead: it is the first start toward a board. There is hardly a doubt about it; here, somehow or other, the trail to you continues.

On the same Italian coast, at Messina, for example, quietly concealed in the sand of salty puddles on the shore, there lives an animal which takes you quite a ways further: it is the amphioxus or lancelet. Its whole life long it is constructed like a somewhat more extreme, youthful ascidian; for the entire length between the spinal marrow and the intestine it has a gristly little staff, called the back chord, noto-chord, or chorda dorsalis. You could not talk about a real, hard backbone as yet. The "board," which serves to keep you straight when you walk upright like a god, is still a piece of cardboard here. But it exists; that is all there is to it. From the nebula in the constellation of Andromeda to this spot, going in the downward direction, there is no formation of Nature known to us which already so much resembles your solid spinal column board as this cardboard between the marrow and the intestine of the lancelet.

And a first fish it is; the lowest of them all—but, anyhow, already a fish. And with it the line is precisely designated, into which the sorting machine has thrown you. The vertebrate, the fourth and highest of those peak branches of the animal kingdom above the worm, begins with the fish. You are a vertebrate, an animal from the amphioxus onward and upward. From here on it is almost as easy as pie to run up the ladder.

All you have to do is to knock on your forehead again, and you will see the first, more restricted step from amphioxus on. You have not only the general backbone board. This board terminates in a ball on top of you: it is the skull, the hard, protective envelope of the brain. The amphioxus has not got a trace of that as yet; its cartilaginous staff between marrow and intestine simply runs out into a point fore and aft.

The first vertebrate to have at least a sort of skull is the lamprey. You know it, as an epicure, but you hardly ever had that high an opinion of it. As a matter of fact, it is the first vertebrate to have a regular brain at all, of all our living varieties of animals to-day. It is true the brain in itself was already a possession of the higher worm, and so the progenitor of vertebrates must have received it along from there. But as it still lives before our eyes to-day, the amphioxus has acquired certain curious habits of life which have rather brought it down in the world, so to speak. It has degenerated as a result of burrowing in the sand, and has almost entirely done away with the higher organs of sense thereby and also subsequently lost its brain, all except a small swelling of the spinal marrow tube. The lamprey, on the other hand, possesses an honest to goodness brain divided in five parts and already duly developed far beyond the worm; and as a protection for this brain, a half skinny, half cartilaginous bladder has attached itself to the still extremely simple gristly backbone at the forward end; something like the first provisional try at a skull.

When you see our delicious Oder river lampreys swimming like little brown eels in their own juice at the merchant's table, you as a layman little suspect what these little animals signify. The lamprey is not an eel; it is hardly what one would call a fish any more in the usual layman's sense. All the way down, at the beginning of all fishes, it forms a group of antique, wondrous vertebrates all by itself. But this very group marks a turning-point without a parallel.

The organ of all your conscious wisdom begins with the lamprey: the head with the skull and the complex brain of several parts. Shaking the head and being hard-headed started right here. Only from here upward could skulls be beaten in. But all the philosophy of Plato, Spinoza and Kant, too, all love of mankind, all longing and despair and conquering the world by the spirit in the head, all swim in the cradle of this little barrel of brown lampreys at the merchant's house. . . .

But you talk loudly in the enthusiasm of your philosophizing, your lower jaw on your skull moves as if in time at every word, and in the heat of the debate you beat the table with your fist. Despite its brain and skull, the lamprey still has nothing of all that. It has no jaws in its big mouth, it has not the slightest beginnings of any limbs whatever in its body.

The shark is the first vertebrate with which you in turn share these things.

A wild robber race, old as the hills, the sharks still inhabit our seas to-day. When man first went to sea, he first learned to tell about the shark with horror. When a seaman fell overboard, a monster in fish form, so ran the story, shot at him and tore the limbs from the body with one bite of its terrible teeth. The word "man-eating shark" was coined as a word calculated to strike terror into all who thought of the sea. To-day we are inclined to regard the terrors of the man-eating fish with somewhat more scepticism, but perhaps that too is just another phase of the specific, phantastic, exaggerating scepticism which characterizes our whole age. In any event, however, a more mysterious sense than physical danger for the human being that blunders into the big fish's element lies in that word. A much deeper, more important bond connects man and shark on. Until the shark, the mouth was simply a hole at the front

Your swelling, red lips, behind which the white row of teeth flashes like a miniature snow-clad mountain range, and wise words of a philosopher welling forth from this human mouth . . . and then a shark's greedy maw: that seems like the last word in the way of an antithesis! And yet, what you have is really a shark's maw. Of all animals, the shark is the first one to show this formation of an upper and a lower jaw. That existed in the world from the shark and lets us talk about the "man-eating shark."

end of the intestine. Beginning with it, this hole passes through a complicated, finally hard bony and yet movable implement. The

shark is the real "inventor" of the snout, the bill, the muzzle, the mouth or however coarse or agreeable you want to call the matter. And it is even more that concerns you; in several other respects it is a veritable human shark.

What actually lends your naked human body its high, harmonious beauty? Just cut off all the limbs, the arms and legs, in your imagination, and a plump deformity remains. Your face, with forehead and eyes, would no doubt still betray the intellectual human being. But if this body wanted to move like that, it would have to slide laboriously along on its belly like a great flesh-coloured snail, and even the face would turn more or less downward. It is the limbs which first make the "human being" possible. On them, man has wandered around the earth. With them, he has conquered this earth. Recall that the invention of implements in a certain sense depended decisively on the existence of your arms and hands; the greatest invention which man has made, the border-line invention which separates him from the animal.

The origin of hard jaws with teeth might have furnished a shadow for the invention too. But just picture to yourself what it would mean if the making of all human implements had to take place with the single bodily organ of the teeth. Think merely of a flint knife, the first product of civilization, as being bitten into shape and beaten with the mouth!

That there was only one mouth, and exactly in the longitudinal axis of the body at that, would alone have been a desperate fact. How infinitely more advantageous is the arm which is on hand twice; two hands which can grab from right and left, and in addition, these two natural clamps independent of the activity of eating, drinking, inhaling and exhaling and speaking, all of which are piled on the region of the mouth.

Your arms as well as your legs, too, go back to the shark; they begin with it. They begin in a simple form, which nonetheless contain all further development in a nutshell. It is marvellous enough how a thing like that could get started in a totally different element at first.

The fish had received the general tube form, fundamentally conditioned by the intestine open fore and aft, from the worm. That board we referred to, the gristly staff of the developing backbone, was placed along the longitudinal axis to support this tube. The lamprey still shows this simple tube form splendidly in a true funda-

mental form. But now the tube, which became more and more strengthened internally, swam off and continued to develop in the shark. It was a necessity that the further organs to originate would more and more develop in double form, on both sides of this body. That already started with the worm, too, but only now did it really become trumps.

Picture to yourself how I mean that, say in the case of the eye (for it is a highly important matter to which I shall come back in connection with the evolutionary history of the human sexual parts). Here is a house with its four walls. In the front wall there is a big door, and likewise one in the rear wall. Now I want to put in windows, so as to be able to look at the neighbourhood as well as possible. It is obvious that I shall put a window in both of the other walls which are still free; in other words, two windows, one giving on each side. An eye on the body of an animal is absolutely nothing else but a window, a dormer-window in the skin for seeing purposes, a window through which light (and with it, shapes and colours of things outside) can be expedited into the nervous system, the brain. The brain of the higher worm, of the lamprey, of the shark lay at the front end of the inner tube inside of the big tube of the body. The front door of the house, the mouth, opened in front of and beneath it. And so it likewise placed its windows at right and left, one giving on each side.

At least in their best-known form, the lampreys already have two eyes placed just that way at the front of the tube, right and left. Its German name, "nine-eyes," probably was given to it because the populace, in addition to these little eyes, took into account the seven round gill holes which are located on each side, behind the little eyes and further counted in the one, unpaired nasal hole separately for each side. A third eye looking out from the belly side would have been of little use and would have been hard to connect with the brain, which happened to be logically located above the mouth and intestine in the case of the vertebrate animal. If anything, a Cyclopian eye on top of the tube, in other words, on the head, would have paid better, and as a matter of fact we have today come upon the track of the astounding fact that such a "parietal eye" or eye in the crown of the head very generally existed in the older evolution of the vertebrates and that for a long while it played a very serious rôle as competitor, and one can perhaps even say as predecessor, of the optics on the side. Living reptiles have an open-

ing in the skull there, and the remnant of a lens and of a conducting organ from the brain. In the case of primordial reptiles and transition amphibians, one still sees this hole in the skull with positively obtrusive clearness in the remnants of bones, which are all that is preserved of them. The lampreys of to-day likewise show the same mysterious trace in the brain, at least. And, as the grand climax, you as a human being have it in the form of the so-called pineal gland in your brain. For a long time, the anatomy of the brain did not know what to do about this curious appendix of the thinking organ. The great Cartesius was for imprisoning the justly famous and equally notorious "soul" in this particular spot; this poor homeless soul. The "queen," the "immortal one," very nearly got into the last remaining ruins of the little hut on an abandoned observation post; into the empty capsule of the hoary old Cyclops' eye. It can well be supposed that this eye in the crown of the head was the first attempt at seeing in the vertebrate's skull, which was still very loose, and that it was even older than the side windows. In the case of animals lying at the bottom of the water or in ooze and keeping a lookout upwards for enemies as did many a primeval tribe such as trilobite crayfish, armoured fish and armoured amphibians, this periscope in the top of the head must undoubtedly have had a sense to it. But it did not maintain itself in the case of the vertebrate, probably because increasing mobility of the head by means of joints, which made it convenient to look upward with the eyes placed on the sides as well, made this eye on top of the head superfluous after all, while on the other hand that very exposed spot up there worked out too poorly in practice, in combat and danger. It was better to have a uniform hard skull mass up there which could stand a hard blow occasionally, rather than such a delicate and fragile thing as an eye. But you see that the Cyclops of the myth, like most such human fairy-tales, was not such a poor invention at all. The only trouble is that the myth did not invent and transform the human being with enough Darwinian acumen in the direction of progress; it makes man revert to something which the lizards had already gradually abandoned as unpractical.

This will at least make it clear to you how the double development of organs, on both sides of the tube, now had to become a sort of necessity generally. The same thing happened with the telephone wires in the house as with the windows of the eye: an ear was put in each of the two free walls. In the case of the fishes, the actual

"hearing ear" as such appears to be still imperfectly developed as compared with a part of the ear which we too possess to this day; namely, the so-called "organ of equilibrium" which is located in the labyrinth of the ear and which the fishes already possess in a high degree of perfection. It guarantees the maintenance of equilibrium to the living body by means of a highly ingenious mechanism. But in the fish house too there is absolutely no doubt about where the ear was to be located. Moreover, the same thing had to happen about locating the locomotive limbs, when these first made their appearance in the shark.

Take the house once more, with a door at the back and in front and a window at the right and at the left. Turn it into an automobile which is to move forward. Where will you put the wheels? On the right and left sides, naturally. And if it happens to be a long tube-like intestine of a motor car, it would just as naturally be best to have two pairs of wheels, two wheels in front, on the right and on the left respectively, and two wheels behind, on the right and on the left. The four limbs developed to a T in the shark according to this principle of an automobile, and these shark's limbs still hang on your own naked, white human body as two arms and two legs. The shark swam straight ahead through the water. It did not know anything else except water. But the two-sided principle of wheels was adapted exactly as well to water. Do you see the little rowboat with the blue flag over there on the lake, frightening away the flirting aquatic birds which rise like a cloud in front of it? Four slender, valiant fellows, in white rowing tights and with tanned necks, arms and knees, drive it on, to the measured beat of their oars. Each one has two oars, one at the right and one at the left. And the boat whizzes swift as an arrow over the sunny surface of the lake, like a jolly springtime fish. The selfsame principle! The sinewy brown arms of these half-naked rowers employ oars as implements, as limbs artificially prolonged beyond the flesh and bone of the arms. The blade of the oar takes hold of the water, throws it away, and the boat flies as if it were running on wheels. The shark for its part did not know any implements as yet. What means it gained had to grow out of its own body. And so, four oars grew on its body tube, four oars grown fast, four fins. Just how they originated in the shark is still something of a controversial question. According to one view, they developed out of soft folds of skin on

the sides of the body. It is more probable that they developed out of the rearmost gill arches on each side of the fish's neck, which had spines of cartilage, so that at first there would have been two pairs of forward or breast fins, of which the one pair gradually slid on down along the body, as it were, and ultimately became the rear or belly fins. Be that as it may; in any event the beginning of everything that we still call limbs in man lay in these breast and belly oars. The shark's breast fins became arms; its belly fins became legs. What was still purely an oar for it became "wheels" for the subsequent land animals; that is to say, they became front legs and hind legs, which moved the body on land as well.

On land! That word is again a clue. True; as you lie there in the grass and stretch your arms and legs in the first warm sun of spring, you are a vertebrate animal above the shark, because you have arms and legs. But new roads stretch out above this "human shark." There is a purple twilight chamber in which you too as a little human being just coming into existence once wore only four such budlike body fins, just like the real shark: at a certain stage, as embryo in the mother's womb. But you as an individual have outlived that long ago, just as all mankind has outlived the shark. You as a finished human being are no longer a shark. For that matter, you are no longer a fish at all. Everything genuine in the fish line starts from the shark. Countless forms come along there, the sturgeon, the eel, the sheat-fish and the pike, all in the water, all adapted to water, all with fins, now in this form and now in that. In your case, however, the fins have really become land limbs. How did that happen? Where did the concept of "land" come from?

Your wise body knows, at another place. The nook for you is very clearly indicated. Only a very little above the shark in the classification, right close to the border where the shark in first line advances to the sturgeon.

You are lying on land here. The golden air of spring flows around you like a heavenly bath. You drink it in with your mouth In the same region where your intestine opens upward into a gullet, there where the primeval gateway of the gastræa's, the polyp's, the worm's tube lies, there you suck air into yourself as well. But the air does not just sink down into the whole works, into your stomach and intestines. Something special, something like a separate bag which greedily sucks air, and only air, is loosely attached to your

gullet; a double bag, one lobe extending into you at the right and one at the left—your lungs.

There are no two ways about it; the lung, too, is a kind of miniature intestine, a feeding apparatus. You as a living being do not need merely fluid and solid foodstuffs, which your genuine intestine transforms into physical energy. You also need air. And since you are an animal, you need oxygen. The walls of your lungs take care of this kind of digestion, digesting air. To be sure, this air stomach of yours has no anus behind, like the genuine digestive stomach, through which it could get rid of the useless waste, the excrement of its air nutrition, as it were. It must expedite the bad aerial excrement, the useless carbonic acid, through the selfsame mouth orifice through which it received its air food. The history of this air intestine of yours, called the lung, happens to be extremely instructive in connection with your further classification among animals beyond the fish.

All vertebrate animals up to and somewhat beyond the shark live exclusively in the water. They too need oxygen there. But they take it in along with the water, and not directly by swallowing air. Therefore, respiration appears here in a way which still gets along with the simple big food intestine alone. The mouth gulps down water directly into the old intestinal tube. The anterior half of this intestine then sucks the necessary aerial food out of the water, just as solid food is worked up and digested in the part lying further back. Holes in the sides of this anterior intestine simply let the superfluous water run off again without any trouble. The so-called gill apparatus of the fish can be derived without a hitch from this principle, which is already clearly indicated in the case of several worms and therefore was already handed on to that lowest fish, the amphioxus: the gills are the actual places for digesting air, on both sides of the gullet; the water comes to them from the mouth and runs off again through the slits at the right and left of the neck, after the necessary oxygen that was swept along with the water has been digested out of it.

The transition from this fish way of breathing to human respiration is furnished very clearly by the so-called mudfish. Widely distributed in very many different forms in distant geological periods, it to-day exists only in three varieties at three places on earth (Australia, tropical Africa and South America), and the most interesting one is the ceradotus, the Australian mudfish. The mudfish still

possesses regulation gills, just like the most genuine kind of a fish, as, indeed, it still resembles a fish throughout, having scales and fins and normally living in the water.

But at the same time it already possesses that deep, baglike intestinal pocket at the anterior opening of its intestine, which in our case we dub a "lung" and which no longer draws air out of water, but swallows and digests air directly.

In this case, too, just as in the case of the four limbs, it is very curious to watch how this bag which "eats" the air in the beginning developed purely for the purposes of an animal living exclusively in water, and having absolutely no connection with breathing at first. A fish in the water can use air for something totally different as well. The more air it swallows and retains in the body, the more its specific gravity diminishes and the lighter it gets, so that it can finally float motionless at any place in the water it chooses, like a balloon in the ocean of the air, without sinking, since its weight is kept exactly equal to that of the water. And therefore, fish from very early in the game got the habit of sticking their mouth out of the mirror of the water now and then, and gulping some pure air instead of merely gill-water. This air collected forward in the intestine, just as the carbonic acid gas does in the case of a human being who has drunk too much seltzer-water; and gradually a special fold developed on the upper wall of the gullet, and finally it became a regular air bag, with which the fish could regulate its weight at pleasure from now on. Two different things became possible now.

The wall of this bag contained blood vessels, and these in themselves eliminated air. That could be exploited for purely ballooning purposes. In the case of fish living in very deep water, for instance, swallowing air through the mouth could be discontinued entirely; for the wall of this intestinal bag up in front produced the air needed to fill it. In the end, the bag might grow together entirely, from the gullet on, and therefore merely form a simple, closed bladder in the interior of the body; and it would still be kept filled with air produced automatically. That is the road which the majority of the fishes travelled, from the shark and sturgeon on upward. This bag became a "swimming bladder" for them, in other words, an organ which first and last had a purpose only in the water and that purpose was regulating the fish's weight.

Conversely, the emphasis might continue to be laid on continu-

ously swallowing fresh air and letting the inner air pour out again. As the blood-vessels in the wall of the bag kept on having a continuous supply of fresh air brought to them, they accustomed themselves not merely to eliminate their own remnants of air but to take up aerial nutrition directly from this new air, which was so very rich in oxygen. What these blood-vessels in the bag did was simply to compete with the gills utilizing water; the intestine (for the bag was merely a turned-in fold of the intestine) began to eat at a new place, and this time it ate not just air which was washed along by the water, but air as such, which the mouth had pumped in directly. The two respiratory processes continued side by side for a while. The air sack still served chiefly as a balloon for regulating weight, but to a certain extent it also functioned as an auxiliary apparatus of nutrition. But now suppose a situation arises where the water for the gills fails; either because the whole sea in which the fish lived dried up or because the water for a time furnished bad and insufficient air, owing to its becoming stagnant and too many inhabitants being crowded in one narrow place, all wanting to distil the air out of it at the same time. In a case like that, the swallowing of free air on the surface of the sea and the hitherto incidental aerial food factory in that gullet sack suddenly became salvation and the main thing. Conversely, the gills became incidental. And if by chance the water disappeared entirely, why then this air bag simply took care of the department of nutrition; it ate oxygen and excreted carbonic acid sufficient for the entire body. Henceforth, the former water-air animal could continue to exist in the open on dry land as a pure air animal, without suffocating to death from "aerial starvation."

Thereby, that intestinal sack automatically became entirely superfluous as a balloon for regulating weight; it exclusively discharged the duties of a digestive machine now: it had become a lung. And that undoubtedly was the way that led out of the fish and on toward man. The mudfish still marks the very border. If it has enough water containing oxygen, it breathes with its gills. If its pool dries up or the water in it becomes poor in oxygen, it only swallows air directly and breathes with its intestinal bag, with the "swimming bladder," which naturally must never grow entirely shut in its case. As an heir coming along late in the day, you have to thank the mudfish for the fact that you "breathe in the rosy light" up there, and are not confined as by a sorcerer's spell in the purple depth of the

liquid element to this day, along with the "spiny ray, the cod and the gruesome misshapen shark."

The very next higher animal above the mudfish shows you the whole tremendous sudden change which the possession of a lung signified. The little croaking toads with their little white throats in their pool of love are singing it for you.

It is true that they too are still sitting in a puddle, engaged in their procreation festivities. But they are just as much at home on land as in the water. Living both ways, the scientist calls them amphibians. In their infancy, as diminutive tadpoles, they swim around in the stork pond breathing with gills like genuine fish, as if according to a hoary, cherished tradition from which their race has not been able to tear itself quite free as yet. But you, too, as a human being still have gill-slits when you are in the womb. This pool with its water warmed by the sun is the common womb for the little tadpoles, as it were. But one day the toad will become a pure air breather like you, it will lose its gills entirely and digest the air exclusively with the same intestinal sack which you too have, with the lung. And thereby it has become a citizen of another world, no longer of the fish world, but of your world.

Its four shark and mudfish fins have become genuine legs, two front legs and two hind legs. Each of these limbs has now received its "board" which supports it internally, just as the back once did; it is an extremely intricate, bony board, ingeniously movable by means of joints. And in the case of the toad, the real crown of the whole apparatus for locomotion on land is already at the end of each limb: that is the paw, the foot. You already see the famous five toes on the hind foot. A large, brilliant chapter of the history of your own civilization begins here with the toad's foot. Man, in the childhood of his civilization, learned to count on his twice five fingers and twice five toes. The basis of his counting immortalized in the decimal system began here. With counting he unlocked the highest of all revelations—the laws of the universe. No God in a burning bush of thorns ever showed man a higher way than this number ten of his fingers.

It was this same five-toed amphibian foot, which in turn had grown out of the cartilaginous rays of a fish's fin, that furnished the hand with which the implement was handled; the implement, which has become the lever of Archimedes, with which man moves the

earth, and in addition it furnished that other hand that held the chisel of Phidias and Raphael's brush.

When once the land animal's body actually rested in stately fashion on its four limbs, and the paw instead of the finny oar resolutely gripped the ground and carried the body along, step by step, the lung contributed something else that was new.

Your little toads are squalling and croaking in their spring bath. And again it seems as if a door burst open toward you, toward the white naked child of mankind lying there in the green grass. The lung is there; consonant with that double arrangement of the body's subsequent organs, it has stretched itself into two saclike points or lobes, one on each side of the principal intestine, in the chest; but as the air streams in and out of it through the common gullet, a sounding wave-beat arises in the gullet, a soft singing breath of wind: a first voice. Your speech too starts with the amphibian! Listen with rapt attention to this cooing and croaking of the frog chorus. From here on there was that too in the world which with you was to become the most wondrous human bond. We human beings forged ourselves together in a higher organization and made a million-headed social individual by means of speech. And by speech we climbed yet one step higher in the rhythmic world of song toward the sacred harmony of the universe. We had that given to us on the road from a pond in the primeval world where amphibians bawled for the first time. When you hear the toads sing, it is an infant sound of mankind, still æons away in the lap of evolution.

But let us continue. You are not an amphibian either, although it clasps you in its ring. What comes next, beyond the toad, the salamander?

§ 8

There it is, lying in the sun, the slender, long-tailed green fairy of the grassy ridge, motionless, as if the heat of the sun had turned it to stone—the lizard.

In primordial days, it once lay that way on the edge of some pool, as a new step beyond the amphibian to you. It no longer lives two ways; but only one way. It is already an air-breathing animal when it crawls out of the egg, knowing nothing about tadpoles which breathe with gills any more. As the grotesque waran, it wags its tail in the burning, waterless desert, where no salamander or frog would have ventured, and this without shrivelling up into a mummy. It grows to be the grim ichthyosaurus, which for a while becomes the fiercest predatory creature of the ocean although it breathes only with lungs. As the iguanadon, it hops along upright on its hind legs, the first real "leg and arm animal," which anticipates your human gait that's turned up to the sun. Lastly, as pterodactyl it flutters through the air, by stretching the old skin, which once projected as a rowing fin, from the little finger to the leg.

And yet you are no longer this lizard either. There you lie, and there it lies, both taking a sun bath, both blissful and feeling good because of this sun, and yet so very different. Your body rejoices in the sun, its warmth fondles you like a voluptuously soft cosmic hand that comes ninety million miles to stroke you, to lull you once more in the great longing of all creatures for light and sun and spring after so much wintry woe. But in the end you get up and put your clothes on. And without the sun, too, warmth radiates out of your white body, from within, as from a mysterious heating plant. Your shirt was cold when it touched you. A few minutes later it is warm. From you, from your body's own well-spring of warmth! This body simply happens to "know" how to heat itself permanently to a certain degree of temperature. And there again it "knows" something of which the lizard still has not the faintest idea.

The lizard is "alternatingly warm," and that is a good name for it. Its blood adjusts itself to the temperature of the air outside. If the sun beats down hard on its scaly skin, its interior too burns through

and through. But when night and cold dew come, and especially when winter comes, its own temperature drops with a bang until finally the lizard gets ice cold too. Its respiration, the circulation of its blood, the metabolism in its entire body do not as yet possess the power to produce so much internal warmth out of themselves, that the body can maintain a certain normal degree of temperature permanently. That still gives its entire existence, as it lies there before you, a definite characteristic which no longer exists in your case. In all that is best, it is really nothing but an eternal child of the sun. It enjoys its good times only when the good sun does the heating for it. Then it is spiritually active and lively, as if it had sipped a rare, fiery wine. But just as soon as even a certain coolness alternates with the warmth of the sun, everything suddenly goes down in it; its life and love and mad capering around are as if paralyzed. And as for winter, many moons long, why then it lies stiff and rigid like a motionless piece of wood in some obscure nook. The lot of Persephone has befallen it; only half a year of real life in the light; and half a year of the barren sleep of Tartarus. It could not live at all in a permanently cold land. And so in this respect it lies here with its green scaly shirt, its long little tail and its merry sparkling little stars of eyes as nothing but a straggler that stood still, a little knight of the primeval world, which mighty evolution once left tremendously far behind.

In very olden days the reptilian crew which populates our museums to-day left an imprint of this in oozy slabs of slate, in the jurassic period, in the trias and even earlier. In the paradisical warm land of the sun, where there was neither cold nor ice at first, certain of this lizard's uncles became ever jollier, ever more courageous on their land which they had finally captured permanently by virtue of breathing with lungs. Some hopped on their hind legs over the warm, grassy plain like kangaroos. Others climbed the trees of the primeval forest, clambered from bough to bough and jumped and finally chased each other from tree to tree, indulging in the most daring leaps. Their breast breathed ever more wildly, metabolism with its chemical process of combustion went on faster and faster throughout the entire body, the blood streamed through the body and its circulation kept getting better and better. Then for the first time that enduring internal warmth developed, at first no doubt just as a more or less unimportant, incidental phenomenon. But once it was gained, it soon proved to be far more than that.

when the climate got worse, when the nights grew cold or, worse yet, when snow-storms came where previously the burning heat of the tropics had prevailed, or when the struggle for existence with its food shortage, over-population or changes in the topography compelled migrations to other, cooler regions, that permanent internal warmth now saved them from the curse of Persephone and, first created as it was by increasing activity, it now helped that selfsame activity to survive in an unfavourable environment. We know for a certainty to-day that such local climatic oppositions were possible on earth in very old geological epochs. There were mountains at a very early time, and lofty mountain ranges have to get covered with snow in the end, even in the midst of a tropical land. We have sure traces of glacier ice from its effects in very primeval strata. But periodic ice-ages that appeared on earth long before the well-known diluvial are likewise suspected. It was undoubtedly at such a time that a group of permanently warm creatures emerged from the alternatingly warm reptile as the next higher stage of evolution, once more outbidding its predecessor. And since you too are permanently warm, that again must have been the line that ran in your direction.

Once permanently warm blood came to have a real protective purpose against external cold, something further and something very important must have occurred hand and hand with it.

There you sit and calmly put your clothes on, one piece after the other; because up here in the northern hemisphere of the earth at the fifty-second degree of latitude, even in the first spring warmth of the shore of a lake in the march of Brandenburg, it at last gets too cold to day-dream stark naked about bald coots and hooded grebes. Your internal heating system guarantees you approximately thirty-seven degrees centigrade. Nevertheless, here in the incessantly moving air, your skin already begins to perceive the steady loss of heat to this air with a certain uncomfortable feeling. It would like a cover which would shut off the outside, as it were; something that would place as poor a conductor of heat as possible between your skin and the air. The woollen or cotton material in your clothes is a poor conductor of heat. Wool serves best of all, But where do you get this wool from? From the sheep, from an animal, a higher vertebrate. At home you have another, really even better material in the eiderdown quilt on your bed. The name tells you what it is; "down"—feathers. This too comes directly from the animal body, merely from a different higher vertebrate,

the bird. In these few concepts, external protection of the body's heat by means of a poor conductor of heat and as such a protective means, the wool-hair here and the feather there, lies the further road of old evolution.

When the lizards had become warm-blooded animals, it became useful against nocturnal cold and still more against the cold of winter for the body to put on a protective covering like that. Two different methods of such "clothing" grown fast on the body made their appearance; here the feather and there the hair. Both must have developed out of the lizard skin which already existed. The genuine lizard, as it lies there, still has scales to-day. It is a striking fact that a feather is nothing else but a somewhat transformed, refined, I might almost say spiritualized, horny scale. The same thing was formerly asserted about the hair, but it would rather appear as if this did not really develop directly out of the scale on the lizard's skin, but out of little knots or little plugs between the scales which first served as sensory organs, as organs of touch. Hair-like formations, as the very finest of projections from the skin serving touch, are found in vast numbers in the whole animal world. When these took over the protective function of warmth, the scale became merely a hindrance and in this case gradually shrivelled entirely away. In both cases, in the case of feathers as well as hair, the real transforming and developing power was probably the cold itself. The antithesis between internal warmth and external cold had the effect of a stimulus on the skin, the blood flowed more strongly to it, the skin became more energetically fed and began to develop all of its formations more abundantly, more exuberantly. And the result was something which in turn proved to be of splendid advantage to its hoard of warmth: the development of hairs and feathers and thereby a precious protective wall against the outside cold. A feathered or hairy, warm-blooded lizard could now maintain its vitality and joy of life even in bitter cold weather. But once it got that far, it was no longer a genuine lizard. An animal with warm blood and feathers was the step to the bird. An animal with warm blood and hair was the step to the mammal.

Hair and feathers are mutually exclusive. Here are two different roads; on which do you belong?

Put your clothes aside once more and ask your naked body again. You have not the slightest start toward feathers. On the other hand,

you still have quite unmistakable patches of woolly hair like islands on you, at least on your head, at the arm-pits and on the private parts. And if you look closely enough, you will see your body everywhere still thickly covered with miniature hairs, which, for some reason (we shall have something to say about that later) have become stunted and been reduced to the level of the very finest tactile tips instead of actual hairs for the protection of the body's warmth.

You are a hairy animal, not a bird. The bird is a special adaptation to the air. It no doubt developed from leaping saurians which whizzed from tree to tree. Further, it immediately made a vehicle of locomotion of its new external means of protecting its warmth, the newly achieved feather. It increased the feather in size to the pinion, transformed its front legs into an ingenious support for these locomotive feathers and so reached its highest goal of evolution, flight; and it has never gotten any further. In the end, flight proved to be a gain for the question of warmth; the bird has it in its power to go out of the way of extreme winter cold simply by means of locomotion, by a temporary change of place. The swallow and the stork can sing you a song about that. When winter comes, they go travelling, and oceans and continents are mere child's play for them on their voyage through the airy blue. But that was the last trump too. With flight, the bird stood still. Follow the bird of prey yonder over the woods; wonderful, how it cuts circles, with a skill that even the wise human being cannot imitate with the same individual freedom to-day. And then consider the green lizard here beside you. That bird is the lizard become warm-blooded, light as a balloon, with a feather dress and with flying pinions. And yet it is only a bird. You with your hair are something more. Every little lock on your body down to the golden down, which just barely shimmers on your arms and legs, speaks of your destiny which ran the other way, the higher way; via the hairy animal, the mammal.

The big sorting machine is starting up for the last time; you are rattling through the outermost holes. It is infinitely easy to prove by a hundred good reasons that you really are an honest to goodness mammal. Your nipples, designed for sucking milk, preach this fact to you. But let a drop of your "very special juice," the blood, flow, and look at it under a microscope. Red globules, from which your blood gets its red colour, float around in it. These blood corpuscles

are round as a circle, and they show no nucleus in their interior. Compare the globules in the blood of other higher animals with it. Strangely enough, the blood of the bird, the lizard, the salamander and the higher fish also contains corpuscles. They are not always round, however, but longish; and they always have a small nucleus in their interior. If you compare yours with the corpuscles in the blood of mammals, such as dog and rabbit, hedgehog and bat, horse and monkey, you invariably find that they lack the aforesaid nucleus, exactly as in your case. And if you take no account of the camels which keep their own idiosyncrasy, you will also find that characteristic round form of the red corpuscles, in contrast to the longish form, among all mammals; again the very thing that you call your own.

But after all, the mammals are still a pretty mixed crowd too. You can separate them into three stories, as it were, in first line. Things still look mighty old-fashioned, mighty shabby, in the lowest story, like grandmother's room on the ground floor, where the spinning wheel still whirrs.

There are the duckbills, very curious customers in contemporary Australia. With an old guard loyalty which cannot be worn out, they still mark the boundary between mammal and reptile with certain characteristics. They still lay eggs like reptiles to-day, though with a few progressive innovations in the way of feeding. Their blood is very noticeably poorly heated to this day, so that you feel yourself carried back to the great divide of the "alternatingly warm" animals. You have overcome all of that very thoroughly, and you are therefore absolutely not a duckbill any more. The so-called marsupials which no longer lay eggs, but carry around their young, which are born totally immature, in a warm brood pouch on the belly, live one story higher. Your human belly no longer has any pouch of this kind. The new little human being grows up in the interior until it is ripe for birth. Therefore, you are not a marsupial either; no kangaroo, tall as a man, no lumbering Australian bear, no snappish opossum that murders the North American farmer's chickens nights and sucks their blood, dangling high up in a tree by its merry, coiled tail when you want to catch it.

But now we are coming to the top layer; the wholly genuine mammals, in the practical sense.

Give me your hand.

This beautiful hand in which so much human art lies enclosed is

a work of art. But it is a wise hand too. The mystic sought to read fate in its lines. The sceptic laughed at that. But more fate actually lies in this hand than in a thousand sibylline books of our wisest men. It guided us once before. Now, for the last stages, you need nothing more than this.

Let those races of mammals above the marsupial pass by you in imagination like a mighty, sullen, trampling, rattling, roaring vision. And then just stretch your beautiful, white hand out against it; and on this rock the whole ghostly apparition will shatter, and the right one which you need will step forward.

Shapes of every sort crowd upon you; they have everything possible except the one thing that you stretch toward them like Faust's magic key; and that, they seem not to have at all; they possess no hand.

Well, how should they have one: so it seems to you at first sight! For the fish walked out of the water onto the land on four fins of a kind, as if on stilts. Then those became four legs. The bulk of the old saurian race normally ran around on four legs, each with five toes; and such descendants of amphibians and reptiles as survive to-day still run on them, in so far as they have any limbs at all. That duckbill still runs on four such paws to-day; forefeet, hind feet, four feet generally. But where is a "hand" to come from?

What really is this hand in opposition to the foot? It is a grasping organ. Therein lies its whole magic. The foot steps out and moves the body along the surface. The hand, however, seizes, reaches, grasps. In your human body, two wonderful things now mix at this point; walking upright on the hind legs, and at the same time, the transformation of the forelegs into the most ingenious kind of a grasping organ. You are a two-footed and two-handed animal.

The fact that there already were isolated cases of climbers among the amphibian and reptile race from an early stage upward becomes important here. The tree-frog hides high up in the foliage; the chameleon (a lizard) changes warily from branch to branch on the hunt for insects. This tree-frog continues to be nothing but a jumper, hopping upward, and where it becomes imperative for it to cling fast, it does not take hold with its forefeet like a gymnast, but it sticks fast to the surface, where it wants to cling, with the balls of its five toes by means of an ingenious experiment in physics, utilizing the pressure of the air. But the chameleon is already different. The five toes of its forefeet and, strangely enough, of its hind feet

as well are entirely grown together into two bundles in such a practical manner that a regular pair of tongs has resulted, which easily reaches right around a thin branch. That assuredly is a step in the direction of our human hand, which has no connecting skin between the fingers, but which can likewise form those grasping tongs at pleasure, by seizing a thing with the thumb, which can be ingeniously placed against the rest of the fingers.

In hoary days of the primeval world, however, there already existed an animal race of a saurian sort, very widely distributed and split up into many different forms, which most strikingly and exactly foreshadowed this human hand (on the forefoot as well as the hind foot). It was at the very beginning of the saurian epoch, in the earliest trias. During a whole epoch of long duration, Central Europe then formed a dry, red desert of sand, poor in fauna and flora. Where water actually happened to appear in this waste, from which the storm whirled up only huge waves of dust and blew them away again, where it appeared as a salty lagoon which was soon filled in and dried up, and gigantic surfaces of temporarily yielding ooze quickly baked under the sun's burning rays, that numerous race roamed around and squeezed its footprints in the pulpy mass, leaving countless criss-cross tracks. These traces were preserved when the mass hardened, and falling dust buried them. The mass became reddish or yellow sandstone. Where these slabs of sandstone can easily be split from one another in the course of quarrying to-day, the old track appears unimpaired, as if chiselled in stone. And it teaches us that the foot of these primeval, phantom monsters of the red desert (there were giants among them as well as pygmies) was really a hand, behind as well as before, a regular hand this time, which already had the same thumb as ours, with a thick, fleshy ball that could be placed against the other four fingers and the rest of the surface of the hand in tong fashion. No doubt these "hand animals" (chirotherians), as they have been called, were tree climbers whose hiding-place must have been the groves of the moist oases, and which perhaps just crossed the oozy ground occasionally when changing trees. Curiously enough, despite the large number and unambiguous character of these tracks, there is to this day no sure clue as to what these animals looked like; whether they still belonged to the saurian sort of primitive amphibians of that time or whether to the genuine reptilian saurians of the period. It cannot even be disproved that of all the lower animal race of those times,

they might have been closest to the mammals' ancestors which were just coming along.

What does remain certain is that the grasping hand, the human "hand" in principle, already made its appearance occasionally at this stage. It appears supernumerarily in the case of the chirotherians, both behind and in front. But that other characteristic attribute of man, walking on the hind legs, was as a matter of fact already tried out very early here and there by genuine saurians. Giants and dwarfs among the animals which habitually ran on the ground raised themselves on their hind paws, kangaroo fashion, balanced themselves straighter and straighter and in the end hopped over the open plain at a fast trot as jumping saurians, in the course of which the short forelegs became regular little arms and no longer touched the ground. The bird received this technique from the reptile. Those hooded grebes in love in the lake run backwards on dry land exactly as you do; they have genuine legs with walking feet, on which their bodies are balanced. To be sure, these birds' arms which have thus become free do not have the hands which the old chirotherians already have. The bird has developed wings here, and thus has again become extremely unlike man. But then the mammal in no case ascended on the line via the bird; it started directly, on its own account, very much lower down, from the primitive reptile. In order to arrive at a human being, you would, in the matter of extremities, have to imagine a combination of the chirotherium's hand and the erect leg of the hopping saurian. The duckbill, that most absolutely antique of all mammals to-day, has nothing of either of these two things. But if we find each of these specialized things so nicely attained separately at the reptilian stage, the question arises whether this tiny remnant of the old transition group does not trot out merely a one-sided adaptation for us in our duckbill descendants, namely, that of four-footed walking, whereas in the genuine transition epoch itself, in which this race must have flourished in the extreme, both numerically and in the diversity of forms, two-legged leaping and four-handed climbing and grasping primitive saurians may also have existed. For in any case it is very significant that among the marsupials of to-day, which are likewise very old-fashioned, and of which we still possess a mighty variegated sample card of adaptations in Australia and America, we have before our eyes forms which hop as well as form which climb by hand.

The universally known kangaroos whizz over the green plain of Australia high up on their hind legs, as mammals. In the same Australian region as well as far off in the American forest, genuine climbing marsupials (phalangers and opossums) clamber around the tops of trees. In their case, the hind foot, which is the kangaroo's "walking member," is especially prettily developed as a grasping member, as a "hind hand," with a completely thumb-like toe. Numerous transition steps which are still preserved alive, make it almost a certainty that the foot animal, the kangaroo, originated only subsequently out of the climbing "hind-hand" animal. You could, therefore, easily picture the road leading to the antithesis of the human foot and hand to yourself as follows: some old mammalian race first acquired those typical "four hands," two in front and two behind, as a climbing race or else had already received them from the saurian days of those chirotherians; and then, as a result of a mode of life, which somehow became changed, the hind-hands (and only these!) became walking feet, which somehow from now on alone carried the weight of the body upright in bird or kangaroo fashion.

But in the rest of his organization, man is no longer a marsupial, either. Shall we not be able to think of such a transformation process, leading via four hands to hand and foot, in force among those higher mammals, that already outbid the marsupials? The only question is, where?

Again these high mammals, which are no longer like marsupials, appear split up in positively unlimited variations of adaptations. But this very principle which you seek appears to be utterly lost to view among them, even in the form of a beginning.

Here is the vast group of many forms comprised in the word "hoof animal." Not a trace of climbers, among them, any more than of purely hopping on hind legs. All four limbs take hold of the ground; to run on them is trump. Here come the elephants, and here the hippopotamuses, the pigs, the camels, the deer, the oxen and the sheep. Here comes the tapir, the rhinoceros, and the horse. There come the mysterious rock-badgers, to say nothing of the many primeval creatures which are extinct to-day. The running problem attains the peak of its solution with the horse. All four legs now go "on stilts" on a single toe only, which a solid hoof protects. Evolution could hardly stray further from our problem of "hand and foot,

grasping hand and walking foot." "Pass on, ye sheep, pass on," therefore.

Suddenly the sea sounds around your magic stool, as if the fishes wanted to come back once more. But only the groups of mammals which again adapted themselves retrogressively to life in the water, come along now—whales and sea-cows. These fish renegades have discarded the hind legs entirely; the uncouth roller of their body runs out behind into a crossed sausage end, and the forepaw has become a paddle fin with immovable fingers. Pass on, pass on!

Here are the sloths, the armadillos and the ant-eaters, the pangolins, the ground-hogs, still very low fellows of the primeval world, in part with tough armour like turtles. They mostly grub in the ground, and their feet have thereby become scratching shovels. A few forms in the primeval forest developed into climbers. But instead of hands, the tapir has developed rigid hooks in so doing; the grubbing hoe being transformed into something like the bent handle of an umbrella, with which it pulls itself from bough to bough. That is nothing for us!

There are grey bands of ghosts in the air, hanging from branches like folded umbrellas—the bats. A broad surface of skin has grown between their fingers, which are gigantically spread out, till a weak flying organ has developed. This is a renegade tendency back to the bird, and the rank opposite of running foot and climbing hand. Pass on!

The beasts of prey appear. In their case the paw has become a weapon in first line. Its most important function is concentrated in terrible claws, no longer for digging, but for seizing prey. Thus armed, the paw is knife, sword and battle-axe. But the weapons have grown fast; they are organs. If the hand were freely movable, as in your case, it could forge weapons of every sort of foreign materials. But as it is . . . pass on!

The rodents are coming. Here is the jerboa, hopping on its hind legs like a kangaroo. Follow the squirrel; how cutely it sits up and brings nuts to its mouth with its forefeet, really almost as if with hands. But there are still no nails on these hand-paws, only sharp, pointed claws. And the foot of the jerboa is absolutely not a man-like walking foot. Nonetheless, there is something like a divination, a prognostication among these little fellows that something is again going to start around here somewhere in the upper story and lead in your direction. The rodents are an old group, which developed very

early and perhaps very much for themselves, out of the marsupial. But this holds good very much more so for a very small, different group of mammals.

Do you see the little brown mounds of earth in the grass, thrust up through the hard ground of the bank with incredible force by a burrowing fellow, which has the strength of a Hercules though only a Lilliputian in size: the mole? It has only two remaining tribal brothers on land now; the shrew-mouse and the hedgehog. The trio forms the group of the so-called insect-eaters. Like the duckbill and the kangaroo, they are the stragglers of a vanished day. No doubt they still knew the ichthyosaurus; probably they were the very first of all those mammalian sorts which rose above the duckbill and the marsupial in the course of evolution.

Much as the popular mind may joke about the Honourable Mr. Hedgehog, he is a primeval world traveller, a grey anchorite, who was present at the dawn of the whole higher mammalian tribe; and is the oldest and the most remarkable of all the mammals of Germany at least. Your respect for it must measurably increase when you learn that this hedgehog in all probability played a rôle in your own origin as man on earth.

The hedgehog neither runs on hind legs nor climbs with hands. It would be hard for an animal to look more unlike a human being. But that again is of no consequence here. Its suit of spines already betrays the fact that Mr. Hedgehog is a very primeval epigone in our day, and still very close to the reptilian ancestors of the mammals. Only three times all told does this curious quill business occur in the realm of the hairy animals; once in the case of very low and very ancient rodents, the porcupines, and once, significantly, in the case of the duckbill, which still lays eggs and is at the border between reptile and mammal. The land duckbill of Australia and New Guinea is very strikingly like the hedgehog in the matter of its spiny coat. In this sense, therefore, the hedgehog begins way down in the scale. Perhaps its line merely runs: reptile, duckbill-like original mammal, marsupial, and then it comes next.

Conversely, however (and now the really decisive factor is approaching), the hedgehog and its comrades appear historically to have set a very definite further line of evolution going. For numerous anatomical and paleontological reasons, the foremost specialists to-day harbour the suspicion that this race of insectivora, which to-day is only a small band, though appearing in many different forms,

which formerly was incomparably mightier, played an important rôle for those other high mammals above the marsupial as a general, mediating junction station. The oldest beasts of prey as well as the oldest representatives of the various groups of hoofed animals, which we still know from fossil remains found at particularly favourable sites in France and North America, all show an increasing tendency in the last analysis toward a definite prototype which it absolutely cannot be denied that only the little band of hedgehogs, moles, shrew-mice and their set, of all the living higher mammals, still seem to bring before our eyes to a certain extent. Such infinitely different ends of branches in the genealogical tree, as, say, the lion and the elephant, the deer and the horse, all appear once to have sprouted from a common root down there; and not they alone. A very special upper group, of absolutely unique importance for our purpose, must undoubtedly lie anchored there, historically speaking.

All surviving insectivorous animals do not continue to be such strangers to the climbing life in the actual ramified thicket of the woods to-day as our Mr. Hedgehog who nightly just rustles through the dry leaves on the ground. On the tropical Sunda islands live the "shrew-squirrels," their external appearance with their long bushy tails reminding you of our squirrels; but in anatomical structure they are rather transformed, climbing hedgehogs and apparently they are also connected with the genuine hedgehogs by transition forms. But that was not always the case; in the old days of their greatness, when presumably the insect-eaters first evolved the ancestors of the beasts of prey and the hoofed animals, they were able to pass on to these honest to goodness hands with adjustable thumbs which could be placed against the rest of the hand, so that at least a part of them must already have possessed the ancient adaptation of the opossums and chirotherians to trees. And we must now picture to ourselves (because there is hardly any other choice left to us) that from such most primitive climbing hedgehogs (to use the word in a mighty broad sense now) the last group of higher mammals too must at that time have originated, which, apart from man himself, we have so far not mentioned: namely, the monkeys—the monkey-like mammals.

The half-monkeys or prosimians constitute the very lowest group of these monkey-like animals in our practicable system of zoological classification. They are so called because they look halfway like

regular monkeys in the customary layman's sense, but for the other half, there is something in their coat of arms that seems to point to quite a different order of mammals. Rodents with the habits of the squirrel or the bilch, climbing marsupials, small martenlike or bearlike beasts of prey: all manner of indefinite traits of that sort seem still to be mixed in with the monkey type here. And there is a truth about their racial history in this mixed character.

Judged by the well-preserved remnants of their bones, the ancestors of these half-monkeys in the early Tertiary once came together very closely with the ancestors of the beasts of prey, for example. At that time they were manifestly at that significant great divide, where most or all of the higher mammals first emerged from the common original form of the marsupial via stages of insectivora similar to hedgehogs, and then became slowly separated. At that time these primitive half-monkeys had closer relations even to the hoofed animals; connections which are so clear as to tempt one to speak of them as "climbing swine." Not that they themselves had first been swine; the fact was merely that all these later types were at that time still merged in a common fundamental resemblance, like cousins in a common grandfather. The thing which later on decisively separated the half-monkeys from this whole kinship with the bear and marten and cat, the elephant, hog and horse, was their holding fast to a thing which everywhere was to be completely abandoned and forgotten by all those others, although it had already been primevally given to them as a possibility, in their ancestors.

The little band of surviving half-monkeys, which to-day inhabits the large African island of Madagascar in particular, in addition to the East Indian and Malayan tropics, had saved the decisive "grasp" in the line of higher mammals.

Give a hand to the "shaking Lemures," (the zoologist has really baptized them after those uncanny mythical beings), as they come flitting out of the nocturnal woods of Madagascar to your witches' cauldron and burst into truly diabolical laughter around you: a hand will place itself in yours, a perfectly good human hand, usually with nails even instead of claws. It is the first hand in all the highest cosmic "coming into being" which directly stretches out to yours, which is the like of yours. Involuntarily you glance down at the foot. Some of these nocturnal shapes manifestly manage, not at all badly and ungracefully, to keep themselves upright on their hind legs, in walking equilibrium, when they have to get down on the flat ground.

Do you see the colossal shadow there? It is no longer a living being, but really only a lemurian ghost of the past of a being which formerly made these wastes of Madagascar insecure. It is the ghost of the giant half-monkey megaladapis, which grew to be as big as an old gorilla. When it came walking along upright through the woods, your eyes might well have deceived you in the moonlight into believing that it really was a herculean human being. But a look downward quickly undeceives you. As in the case of the opossums and chirotherians, the foot itself is still only a hand, a climbing hand, on which the innermost toe (our big toe) functions as a grasping thumb. This "hind hand" belongs up a tree, and its "walking" is just a makeshift. Here, too, although we are already in the uppermost story of the mammals, we still have to await that mysterious last step. It cannot be denied, however, that in other respects we are already approaching your body and its demands with giant strides in the very last stage at this point. Despite its gorilla stature, that giant is the least advanced of all of them. But just conjure one of the small fellows of the half-monkey tribe from the east, over the wide, dark Indian ocean. It is called the kobold maki or tarsier; Tarsius in Latin.

It is almost all eyes, huge nocturnal eyes, as the strange little face stares at you. All of the oldest experimenting seems to be repeated once more, all jumbled up, in this gnome. As the result of a unique stretching of the tarsal bones, its legs are extended in jerboa-fashion. And as a matter of fact, it leaps with them from branch to branch, like a tree-frog; but nevertheless the actual foot which supports this jumping machine is the well-known hind hand with thumb of all the half-monkeys. And from the tree-frog, the trick reverts of being able to suck itself fast to perpendicular surfaces with the balls of its toes, by means of that experiment in physics with the pressure of the air.

Suddenly you see injected into this seeming repetition of primeval things brand-new peculiarities of a different kind which clearly point upward. To explain them, I must go somewhat farther afield; more specifically, back into your own love-life and its sequent phenomena.

I must tell you something about mother-love.

Not about that mother-love of the soul, which has its seat in the mother's brain as an instinct which nothing can check. But about an internal service of love and a sacrifice of love on the part of the wise maternal body itself, for the benefit of the still unborn child.

§ 9

You know what makes the birth of a little child such a terrible matter with us human beings: blood flows in the course of it. It is not enough that this little child in the mother's womb has already grown so big that it takes a tremendous amount of pressing and stretching with all the attendant pains on the part of the good mother to squeeze it through the narrow gateway, the only one afforded by Nature, in the maternal body. At the moment of innermost parturition, a very serious, bleeding wound is torn in the mother.

Originally (as you will remember), the whole act of this child's coming into being began with a single cell in the mother, the ovum-cell, completely separating from the ovary, from the mother's original bearing organ. That at least was a purely peaceable act, of which the mother noticed nothing directly. Indirectly, to be sure, somewhat later a certain effusion of blood was connected with this, mostly not of a particularly dangerous character—the mature female's universally known "periods." But that was entirely a thing in itself, distinguished from everything having to do with the life of a child by the very fact that it made it appearance only when the ovum was not impregnated and therefore did not come to any further development. Only when a strange and likewise independent sperm-cell came to this ovum-cell did the development of the child begin; and this, too, took place at first without any maternal pain whatsoever; in fact, the innermost act of cell fusion (which by no means synchronized with the spiritual act of procreation) took place without any additional act of her own or any agitation of feelings on the mother's part. At a certain stage in this development, however, things changed tremendously.

The child which was coming into being needed to be very vigorously nourished by the mother! For this purpose it put forth a special organ which can be compared to nothing quite so well as to a big root. As it grew, this tap-root struck against the inner wall of the maternal organ in which the new little human being was ripening, namely, the wall of the so-called womb; and in so doing, it thrust

itself along with its sucking fibres into a part of this womb, as into fertile maternal soil, and from now on the pulsing, living blood of the mother adequately fed it through the wall, both with liquid food and with respiratory substance.

And this continued until birth, without any let or hindrance to their mutual well-being. But just because this process of taking root was so closely interwoven (the basis for its splendid functioning), there could not exactly be what you might call a gentle solution or separation here in the course of the act of birth, which after all was necessarily a fairly violent matter in view of the whole circumstances of the case. Instead of this tap-root being pulled easily and smoothly out of the maternal ground, as if out of a sheath, when the little inmate started to emigrate, the ground was torn up at the place where it had grown fast, and the act of parturition even tore along lumps and shreds of the surrounding surface. The well-springs of nutrition, which hitherto had fed the root through the filtering, fibrous walls so peacefully, now were suddenly and rudely bared and cut into far and wide, so that the stream of the fountain was bound to gush forth into the open, unchecked. This stream, however, was nothing else but pure maternal blood. And so it had to gush forth wildly for a while and flow off through the portal of birth, arousing fear, until after a while a natural, automatic lock inhibited the matter at least to such a degree that normally the mother could escape without danger to life or permanent harm.

The piece of mother earth which was thus torn up likewise came to light at the close of the act of birth, particularly the crude chunk where the actual terminal texture of the root had become inseparably entangled and interwoven with the spot of ground nearest it. The popular imagination had already given this piece, which until then was the actual "soup bowl" for the little child in the purple maternal depths, a name which was not so bad at all, calling it "mother cake" (in the German vernacular) on account of its shape; and this, long before the actual facts of the matter were clearly understood. The technical medical term is placenta; which is just "cake" translated into Latin. The placenta, as you know, together with a few other internal stage properties of the child which are now torn and have become superfluous, customarily leaves the maternal portal a short while after the child itself; mostly after this child has been freed by outside help from the connecting root which is now useless (by cutting through and tying off the umbilical cord).

You can well think how the inventive imagination and the whispering and apprehensive superstition of less civilized peoples busied itself from ancient times with this separate "wonder cake," which remained lying there as a dying remnant, covered with blood, between the delivered mother who continued to live and the liberated child which continued to live; and how myth after myth was invented at random about it. We know to-day that the wise body, in this case the female and the infant body, again gives us a particularly illuminating lesson about the connection between man and the animal here.

Man is by no means the only animal which possesses this infantile blood root, this placenta, by virtue of some special gift. You will look for it in vain, to be sure, in the case of the salamander, the lizard and the bird. It is easy enough to see that these animals lay eggs in which the young mature; which then continue to lead an absolutely independent external existence, which cannot possibly have any physical connection with the mother in the sense of that long tap-root. At most, something of the sort would only be possible where the eggs happened to be hatched out as an exceptional case within the body of the mother and the offspring slipping out of the egg is carried around for a while in the interior. In a case like that, which invariably remains the exception among the lower groups of vertebrates, we do as a matter of fact occasionally see the beginnings of a blood root for the child; as in the case of some sharks and once likewise in the case of a strange toad, the Rhinoderma darwinii, where the father, curiously enough, drags around the eggs, which have been laid by the mother, in a pouch at its neck for a while; I shall come back in greater detail to this case, which is a splendid example of the care of the young twisted around the wrong way.

But in the lines of higher vertebrates running beyond the fish and batrachian, this became more and more superfluous as the eggs, which were laid externally with as firm shells as possible, received a more and more extensive store of food in the form of the yolk. This yolk, as you know from every hen's egg and which you appreciate as a good morsel, is nothing else but a large piece of thickly buttered bread, which has been prudently put in as food for the little nascent animal for the duration of its internment in the little locked chamber of its egg-shell, and which normally is also completely con-

sumed by it during this time. Reptiles and birds continue to be the real representatives of this method to-day, and as long as the old reptilian saurians of the primeval world formed the peak of the vertebrate race it was the prevailing and the exclusively reliable method.

When the mammals came up in the world as new and really the most brilliant peak of all, this matter at first seemed to remain just as it was. Despite the fact that they afterwards suckle their young, the surviving representatives of the original saurians, our duckbills of to-day, still continue to lay eggs, as you know. And this not only means that they continue to bring their offspring into the world in a more or less thick egg-shell, an egg-shell which in the case of the land duckbill is like parchment and in the case of the aquatic duckbill is positively chalky and which has to be broken outside of the maternal interior by the "chick," by its own independent action as it becomes livelier, with a special "egg tooth," a provisional sharp tooth-like point in its upper jaw; but it also means that in addition to the nascent young itself, a piece of "bread and butter," namely a nutritious yolk, is still served in these eggs in the old fashion.

If you look very closely, however, you will discover that a slight change is just beginning to be indicated again. After the duckbill's egg has become detached from the ovary, it stays stuck for a while in the maternal oviduct before it is laid; and during that time it continues to be supplied with food in the form of the mother's nutritive juices, which drip down on it and pass through the shell, which lets fluids through for just that long.

One step beyond this, and you could well picture to yourself that this process of feeding the offspring directly would come entirely into the foreground. The offspring would already be so richly supplied with maternal nourishment in the interior that it would no longer need any "bread and butter" yolk at all. The permeable, soft egg skin in there would press as closely as possible against the inner maternal wall, so as to make the most of the good things that were dripping down, like a person who puts his mouth close to the bung-hole of a barrel. And the little embryo in the shell would for its part crowd as closely as possible against this covering, so as to suck up the good "eats" garnered there as completely as possible.

As a matter of fact, you already do find this obvious continuation among the representatives of the next higher group of mammals, namely, the marsupials; the kangaroo, for example. This method,

to be sure, has not been developed quite to the point of perfection here either, and therein, it is fairly certain, lies the reason why the kangaroos happen to be marsupials or "pouch animals"; why they have to drag around their young, which at birth are still pretty poorly nourished and, despite the absence of an egg-shell, extremely weak and immature, for quite a while with them in a sort of "artificial womb," that is to say, a warm external pocket of skin on the mother's body. Just a few marsupials of to-day, however, again show a step toward a repeated improvement of this method.

I told you in a crude but obvious metaphor that in the case of the eggs of reptiles, birds and duckbills, the yolk constituted a piece of "thickly buttered bread" for the young in the egg, the little embryo. It was already the custom there, that the embryo slowly ate up this piece of bread and butter by keeping it enclosed in a big sucking-bag, which as such was in turn connected with the embryo. The place where the embryo held this sucking-bag fast in mighty convenient fashion was not this embryo's mouth, but lay directly at the intestine itself. When the last of the piece of bread and butter had been entirely sucked away, like a piece of sugar in a child's sucking-bag, the sucking-bag shrivelled up and its last remaining little tip closed up the spot where the connection was made, the sucking opening in the intestine of the little embryo, like a nice little cork.

You yourself, as a grown-up human being, significantly enough still have a little cork like that to-day over your intestines, on the naked surface of your belly; you call it the "navel." You have it, although you know perfectly well that you did not crawl out of a bird's egg nor a duckbill's egg.

Few things on your naked body look so utterly superfluous and yet tell so much. You can really become a philosopher just by looking at this navel alone, for you penetrate into the universal mystery from its most sacred angle, from the nature of man. All you have to do is to be able to understand the revelations of your naked body.

You still possess this navel to-day not merely as a dark souvenir of saurian-like and duckbill-like ancestors; which once really did carry their sucking-bag with its stock of bread and butter here on the belly as an embryo. The continuation of the story happened this way.

The marsupials were able to get along without the yolk one day and it began to disappear, because that higher method of internally feeding the embryo directly from the mother, which had already

been introduced by the duckbill as an auxiliary measure, gained more and more decisive importance. The sucking-bag, however, kept right on being produced at this embryonic stage. Then the marsupials, at the dictate of the "Good Fairy Utility" (meaning, in the direction of the most useful, under the compulsion of Darwinian evolutionary necessity), proceeded to utilize this old sucking thing, which had become more and more useless as far as its old purpose went, for an improvement in the new situation, in which the nutrition was obtained directly from the mother through the covering of the egg. They pressed the old sucking-bag, the yolk sac, squeezed out as firmly and widely as possible, against the covering of the egg, and began to suck with it at the covering of the shell, which now kept on being continually covered by nutrition from the mother.

One marsupial, the pretty, white-spotted pouched marten, was so successful in this respect (and still is to-day) that the sucking-bag together with the egg covering already grow directly together with the maternal wall.

Simply imagine that this process of growing together takes place every time and at a particular spot; that it represents a regular taking root by the sucking fibres of the sucking-sack in the nourishing maternal soil of the womb, which is rich in coursing blood; and that the point of the sucking-bag which runs to the embryo's belly gets drawn out like a long stem, and you already have your own human formation described above in principle. The place where the growing together occurs is what is called the placenta, when it is violently torn off at child birth; and the long sucking stem is the most essential content of the umbilical cord. That last spot where the stem on the infant's body shrivels away after being cut through by the midwife continues to be the permanent navel in the middle of your body, in your case as well.

And this is undoubtedly the way the matter developed in fundamental principle. Only one little alteration still took place in it.

While the majority of marsupials employed the genuine sucking-bag of the old yolk as a new sucking device for absorbing nourishment direct from the mother (until that genuine taking root in the case of the pouched marten, which was already starting), you find a very slightly different utilization of the stage "props" in the case of a very few marsupials which are still living.

In addition to the big yolk sucking-bag at the embryo's belly, there was already a second sort of sucking device in the egg among

the saurians, birds and duckbills. Originally, in the early stages of the little being, this too formed a sort of regular bag, merely with the difference that nothing was sucked out of it, but on the contrary, something was poured into it from the embryo. It formed a sort of little urinal for the embryo, which was still very young, into which the nascent little lizard or bird at first poured the waste matter separated by its kidneys, as into a big provisional bladder. At a somewhat more advanced stage in the life of the embryo, however, this little urinal was put to its real sucking function: it became an air sucking-bag, with the help of which the air that entered through the porous egg-shell could be transformed for the embryo's circulation of the blood.

You will recall that the embryo of a lizard or a chicken first develops gill-like formations in its egg, just as if it wanted to live permanently in the water later on and breathe only air in water. Then it develops lungs in its breast, in other words, the real organ which it will use later on in its life in the open. But as a matter of fact, as long as it is in the egg, it does not use these lungs. Instead, it uses that special air sucker on the belly, which as such is neither a water gill nor a land lung, but just happens to serve the little mystery of life in the egg-shell, serves to supply air in the interior of the egg-shell.

You must always picture an embryo to yourself as a very strange, mixed little creature. On the one hand, it more or less closely follows that fundamental biogenetic law which forces it, for instance, first to form gill-slits like a fish. Then as it develops it runs toward its ultimate goal of the bodily form which it is really to have permanently in its later, mature life; in other words, it heads toward the lizard or the bird, which as such will always breathe with lungs, and so it gradually builds up lungs in the mysterious urge of its cells. But while it is executing all of that on itself, step by step, it must likewise live as a whole, it must be fed and must breathe, in order to be able to form itself. For this purpose, very special separate aids are given to it just for this embryonic period. The hard egg-shell which yet lets air through is an aid of that kind; so too is the yolk, the big sucking-bag around this yolk, in other words, the yolk sac; and this second sucking device, which originally hung out of its body as a little urinal but afterwards became a big air-sucking device, is likewise one of those special aids. In a certain sense, these apparatuses form one whole temporary organism of mediation, which

remains part and parcel of the embryo's body and life, in the embryo's service, just as long as it is necessary for the little one, but which immediately drops off, dead, when its time is up.

One is almost tempted to resort to the concept of the "wet-nurse" once more, which we found to be an expedient among the worms. There, too, a hybrid being interposed itself between the genuine parent animal which reproduced sexually and the genuine offspring; and sometimes this hybrid being was simply there for the sole purpose of having its interior eaten up clean by the young and having its hollow dry sausage casing used as a sort of egg-shell. The present case is certainly not entirely like that but you are seriously reminded of it, particularly if you undertake to define clearly just what this whole complex of living organs really is in the case of the chick in the egg, whether it is a piece of the mother or a piece of the child. It actually is neither the one nor the other, but is a temporary, intermediate body of "wet-nurse" character, even though not quite so highly individualized.

For real efficiency, the air-sucking device had to stretch out as much as possible, as long as it functioned in the shell, so that its surface could suck up as much air as possible. And so we see how, in the reptile's and bird's egg it finally opens up above the end of its stem for all the world like an umbrella, temporarily covering the whole embryo within its shell. The scientists call this special air-sucking organ of the embryo the "allantois," so as to have a foreign word; it means urinary bladder in Greek, and is meant to recall this sucking organ's initial function as a secret little urinal. The name is a bad one, however, since it does not embrace the much more important matter of respiration as well.

In any event, you see this much: from a very early stage a second sucking device existed at the embryo's belly in addition to the actual old sucking organ of the yolk; and this second one occupied the outside position right under the egg-shell. As the yolk disappeared, and the necessity developed for sucking all the nourishment directly from the covering of the egg and from the dripping maternal roof above it, just as the air for breathing had hitherto been sucked up, some sort of an arrangement had to come about between the two. If the former inner yolk sucking-bag was now to suck at the vaulted arch, the air sucker would have to make room for it to do so. In the case of the duckbill, which still has yolk in its egg, but at the same time already gets some nourishment from the lining of the womb,

you already see these two sucking organs honestly dividing the terrain about equally between them; air is sucked under half of the egg's dome and nourishment under the other half. Among the bulk of the marsupials, however, this was changed so that all of a sudden the air sucker, which formerly had the whole field to itself now finds itself completely crowded off the map. The entire surface suddenly belongs to the organ which sucks nourishment. In this case, the air-sucking organ is permanently degraded to the rank of a mere urinal until the end of the embryo's development. But how does respiration take place now? Very simply: the victorious organ for sucking nutrition at the outer works of the fortress has taken over the task of sucking air as well!

An alternating possibility like that must not surprise you. Blood, that "very special juice," is the same magician who really performed the work in both cases. As a matter of fact, blood brought in the nutritive substances here, and there it brought in the oxygen as air for breathing purposes, from the very beginning. Blood governed both sucking organs. If heretofore its work was divided between two sucking organs, it could now perform both functions at the same time in one and the same sucking organ.

If that is the way matters stand, you can see at once that they might have been the other way around. It is conceivable that the air-sucking organ should have triumphed in the end by simply taking over the work of the organ for sucking nutrition.

Among several marsupials you see clearly how they stubbornly preserve their air-sucking organ, in contrast to the others, at least at a narrowly circumscribed place beside the nourishment sucker. The so-called Australian bear does so, for instance. This gradually sucks into the wall of the mother's womb in a particularly root-like form at this very spot. The oxygen filters directly from the mother's blood through the porous walls. In the case of the so-called marsupial badger, this process of striking root is so unmistakable, that one can already speak of a first formation of a placenta. But you understand that this is now formed from the original air sucker (from the "allantois," to use the technical expression).

There is no doubt about it now; here and not there began the method of formation, which became the decisive one for all higher mammals right up to yourself: namely that not only was the process of taking root firmly and ever more firmly continued, but that the process of taking the firmest kind of root was now unalterably car-

ried out only by the old air-sucking organ; and, further, that this air sucker more and more decisively took over the work of sucking nourishment at the spot where it sucked air, so that finally any special work by that other organ, the old yolk sucking-bag, became absolutely superfluous.

Exceptions where the old yolk sac still participates in transmitting the food supply from the mother to the child are very few among the higher mammals. Something of the sort still happens in the case of the horse and the pangolin, but it is only an immaterial, fleeting, temporary auxiliary measure. In general, the old air-sucking organ has absolutely triumphed on all sides among higher mammals. The human being's placenta, too, always develops only from this original air sucker striking root, under all circumstances and in the case of every new little human being coming into existence. It was in its full strength and glory at your birth, too, and its tearing loose was the sole cause of that terrible bloodshed at the end; while your other old inherited embryonic sucker, the original yolk sac, had at this time shrunk together almost to the point where it could no longer be recognized and at the most was still permitted to play just a small part with its stem as external support for the umbilical cord, whose chief content right up to the time when the midwife cut it with the shears was likewise only the sucking canal of the victorious rival.

But now—and that brings us back to our little gnome, Tarsius, the small nocturnal lemur—the way in which the victorious sucking organ took root in the maternal source of air and liquid food among the higher mammals was by no means always the same; very instructive differences appear in special cases among the several groups.

You just noticed in the case of the marsupials that this root question can clear up matters of racial history; it is quite certain that old marsupials like those Australian bears and marsupial badgers, which still point so obviously to-day toward the genuine embryonic rooting method as practised in the upper story, are closer to the highest mammals and therefore to man in the classification of animals than are the rest of the surviving marsupial race. Among these high mammals you encounter the fact that the form of taking root sometimes is such that the entire upper surface of the egg on the basis of this great sucking apparatus puts forth root fibres, which

sink into depressions in the wall of the womb as if into the fertile soil. In this case, the hold of the root, dispersed over so many relatively weak individual fibres, proves to be still so loose, that at birth it is easily pulled clean out; parts of the maternal ground are not torn up with it, therefore, and serious bleeding does not take place. The pig, for instance, enjoys this agreeable situation, which one would gladly wish the poor human mother. In other cases, only a certain number of definitely distributed bundles of stouter roots sink into the maternal ground from the egg covering, as tongues of the greedy sucking organ. That is the case with the sheep, for example. Here, too, the ultimate pulling out process takes place with little harm done, if any. But in the end you come to animals where this can no longer be done without causing a small blood bath, so intricately have the tangled roots become interwoven with the nourishing ground. Among the beasts of prey, a root base composed of many fibres forms in a ring around the middle of the entire egg covering; but there the root fibres already are so tenacious that the ground breaks and tears up with it when it becomes detached. The climax, however, is reached where the whole strength of the root has concentrated itself almost entirely or entirely on one single spot, and bitten into it, never to let go again.

That is really the form of the oldest method, which visibly begins with the marsupial marten and the marsupial badger. But at the same time it is also the very highest to-day; for thus it is in the case of man. It is likewise found among a few other higher mammals in between. Just which ones those are becomes important now.

In first line they are our Mr. Hedgehog and associates, in other words, insectivora again. That corresponds to the genealogical tree which we constructed for your human body on the basis of other reasons. And then, beside man up, they are all the genuine monkeys and anthropoid apes; and then, on the line between those two end points—you might guess it—all half-monkeys. There is only one among them which really counts this time and that is our old friend Tarsius, the gnome. Of all the lemur tribe, it alone has the genuine root boring in at one single spot in the ground of the womb, and doing so with particular thoroughness; it is well called the "discoid" placenta, the human placenta. The other half-monkeys all tend toward the pig's method.

On the whole, it is difficult to interpret this matter otherwise than

as follows. This sort of humanlike root started with the insectivora, this being the racial group from which most or perhaps all higher mammals evolved. Incidentally, the rodents, undoubtedly a very old group, have it too; likewise the bats which were very closely associated with the insectivora from a very early time. Then a part of the higher mammals which were developing wheeled off on a large scale. Ruminants, horses and others abandoned the initial method and sought other ways of cultivating their bed of roots. Even the beasts of prey in part turned off. The bulk of them followed the swine, at least in this respect, though otherwise separating as far from them as heaven from earth. A single branch, on which sat the little gnome, Tarsius, preserved the old method. Since this very method is still man's method to-day, there is not much else left for us to do but learn from this badge on our body that the line to us ran in the neighbourhood of the prosimians via the old gnome, Tarsius, at that time, if it ran through monkeylike creatures at all.

We know the direct documentary evidence that the little Tarsius tribe is as old as the hills and that it already lived in early Tertiary times, and was much more widely distributed than to-day. Petrified skulls of these little gnomes (of a closely related sort, at least) have been found in North America; and these, despite their small size (they are about the size of very small birds' heads) really have something "human" about their modelling, there is no getting away from it, and this not in any individual concrete trait that can be grasped anatomically, but in the general impression.

Anaptomorphus homunculus is what Cope, its discoverer, who himself believed in animal ancestors of man, significantly called this old variety. Homunculus. . . .

Be welcome to the planet of the hour!
Yet breath and speech suspend! A work of power,
A splendid work, will soon be here displayed.

§ 10

No matter how the mystery of Tarsius, of the primeval human gnome, might be solved, one thing is certain: what we to-day call a "monkey" in a more restricted sense must have originated from half-monkeys with a similar rooting process in the placenta, in an hour that was big with fate.

The word "monkey" covers a whole lot of ground and embraces a series of pictures of many diverse shapes: from the cute little yellow tamarin and the tiny, twittering ouistiti, which the Parisian ladies carry in their muffs, to the black sapajou of the South American jungles; from the quaint long-tailed monkey to the grotesque, bestial, red-nosed mandrill; and from the slender gibbon, which trots out for us the perfect living image of our seemingly caricatured plush monkeys in the toy shops, to the horrible, broad-shouldered phantom of the forest, of more than human size and shape—the Old World gorilla.

Who ever disputed or could ever dispute that, in external properties, the monkey more closely resembles you than any other creation in the entire known universe!

Naïve savage peoples, which had not the faintest inkling about Darwinsim, asked themselves whether the monkey were not merely a human being in disguise. The artist's eye, which fastened on the naked human body as on a revelation, has preceived the monkey as a caricature of this glory in all ages: but a striking resemblance, even though it is a distorted one, invariably belongs to the very nature of caricature. When Linnæus set up his system of classification as a first rough orientation in the great terrestrial Noah's ark, more than one hundred years before Darwin, he could find no other spot for man, anatomically, than right next to the monkey. Those are naïve feelings of mankind extending over thousands of years; samples of feelings from the most widely different camps, and all showing the same result. Nagging and reactionary wisdom of to-day would like to persuade you that this evidence about things amounts to nothing but learned tomfoolery and the spinning of hypotheses on the part of some faction of scientists or other. But

go to the circus and listen to the plain people, hundreds of them every day anew, marvelling at Consul, the chimpanzee; take your children to the monkey theatre and let them be the judges. Darwin's idea is a privemal, universal idea, which is simply bound to be thought anew, again and again, by children, minors and savages and in the end by wise men and professors too.

And now the simple continuation of our train of thought above joins this resemblance, which was not hatched out with elaborate care around the conference table, but literally cries to heaven.

You have before you land mammals, all of which now consistently follow the way which the little gnome among the half-monkeys first took and which you as a man still follow, in the matter of their embryo taking root in the mother. Particularly in regard to the stem, with which this root is attached to the new little being is all monkeykind positively mankind too from now on. A slight tendency to put forth a secondary root beside the main disc of the placenta's root does not get established among the highest apes which most closely resemble man, such as the gibbon, orang-outang and associates; but this proves, at the most, that a certain part of the monkey tribe still living to-day subsequently executed another sideturn on its own.

Only very recently has attention been called to these truly astonishing coincidences, particularly since the first genuine material regarding the embryos of the anthropoid apes became known through the self-sacrificing endeavours of Emil Selenka, the unforgettable anatomist and traveller. These coincidences constitute the chief value for the Darwinian demonstration, a far greater value even than the general external similarity of the monkey embryo and the human embryo, which has been so frequently discussed and latterly elucidated with pictures. This similarity, to be sure, exists to an utmost significant degree. You will recall how not so long ago a big newspaper feud started over this purely formal, external agreement. It was asserted that exaggerations and inaccuracies had crept into embryonic pictures of this sort, which had been widely distributed among the public, had been made markedly diagrammatical in character and had been redrawn and augmented for definite educational purposes. The details of the matter, which touch the unusually difficult and complicated question of recasting scientific drawings to make them intelligible to the public, does not concern us here at all; I simply want to emphasize for safety's sake that

not the slightest change has been brought about in the real value of these scientific facts as proof by these extraneous and in part eminently personal discussions. That general similarity of the monkey and the human embryo, which in any event is a striking one, further the existence of fishlike gill-slits, which I have so often mentioned, the existence of a uniform system of finlike limbs, of an external tail, of an embryonic hair covering and many other formations corresponding throughout to lower animal stages in the human embryo too, and lastly, above all, the similarities which we just discussed in the feeding of the human embryo and that of the anthropoid ape can as a matter of fact be examined in the special monographs and textbooks of embryology of Hertwig, Kölliker, Selenka, Keibel and others, all of which are absolutely above reproach, and can be supported by the very best material which modern scientific research possesses. Among the authors and champions of these very exact pictures there are opponents both of Darwinism in general as of the fundamental biogenetic law in particular, so that every faintest possibility of being subjectively influenced by excessive friendliness toward doctrinal opinions is entirely out of the question.

For the rest, you have other traces of that little side-turn which a part of the monkeys of to-day executed, and which I just mentioned. Those tiny tamarins and marmosets of tropical South America, which are manifestly scions of the great family tree which early became isolated and lost their way, deviating in a direction all their own, have lost not only the humanlike nails which the half-monkey already almost entirely possessed but also the ability to place the thumb, at least (not the big toe) against the rest of the hand. Retrogressions like that happen everywhere now and then, but do not change the main picture in the least.

In another group of decidedly more consistent Americans, to which that sapajou belongs—an acrobat without its equal, and black as the devil—the grasping hand found a temporary aid in a very particular thing, namely the long, sensitive tail seizing objects in hook fashion; the "grasping tail" or prehensile tail. A hook grip like that has most sense for a climber which keeps on growing more and more daring, whose climbing finally turns into swinging, so that grasping becomes a mere matter of hanging on in the swift acrobatic trapeze act. The hand adapts itself to this in turn, by letting the thumb get quite stunted, hooking on to the bough with four closed, crooked fingers. But this swinging tail did not make its way among

the bulk of the moneys; a number of them and all of the anthropoid apes from the gibbon to the gorilla have no visible tail at all, entirely in human fashion. Only a tendency toward the swinging hand, at least with a somewhat shortened thumb, persists throughout in the monkey race of the Old World up to those which most closely resemble man. The undiminishing demand for swinging, which going the limit of high living in trees imposes, is in general responsible for that; it is the great imperative adaptation which likewise holds the foot in the case of the genuine apes, right on up to the gorilla, in its magic spell. This foot continues to be a grasping organ, on which the big toe seizes hold like a thumb; and this holds good for all monkeys without a single exception. It is undoubtedly a genuine foot anatomically, in the details of its bony structure. But in its functioning it does manual service, now as before.

And yet, when you suddenly look down now from the monkey's prehensile foot to your naked human foot, not seeking this human foot in the monkey, but wandering from the monkey to you, something must quite suddenly take you by surprise, the surprise of something which is really a matter of course and which your thought, straying afar, simply did not happen to hit upon.

This naked human foot is a walking foot. But what is this; is it not a very queer formation as such, and anything but intelligible from its use, at the same time?

Something queer about the human body! . . . are we not heaping abuse on our sage as a reward for having solved one mystery after the other for us for such a long while? Since time out of mind, two souls have been at loggerheads about the naked human body. The ascetic has always found it atrocious generally, a temple of sin and raw flesh, and he would like best of all to have it buried during its lifetime, so that nobody could ever catch it anywhere. To the artist, however, it is a veritable temple; an incomparable poem of the cosmic spirit, speaking to us in terms of logic and rhythm. How have not artists' eyes, artists' hands striven to hold fast the magic melody of the poem, which, like everything that is most glorious in this world, sounds warm and enchanting just for a few sunny days of the individual in full bloom, vanishing all too swiftly; to hold it fast as one carved a song in bronze and marble, as one immortalizes it in gay characters on parchment. But in the artist's eye there lives not only what has already come into being, there lives in it a creative power of its own as well. When the artist is completely absorbed in

his object, he himself becomes the law by virtue of which it originated in the universe and by which its perfection will be measured. In ancient Greece, from the days of Pericles to Alexander, when they succeeded for the first time in copying the naked human body in all its strength and beauty in bronze and marble, so that the statue seemed to breathe and radiate warmth, it was first felt with full consciousness that man's body, of godlike beauty as it was, yet possessed certain slight defects of style; defects, which the artist, thanks to his inner, independent vision of the laws of art, would gently have to help out in the course of reproduction, in order not only to save in permanency the picture given by Nature, but also to confer upon it an additional eternal value of completest perfection. This need of making corrections appears, not obtrusively but yet noticeably, particularly in the later bloom of Greek art. It was thought that despite all the nobility of the skull, the head of the naked human being was just a trifle too big for the æsthetic proportions of the whole, and they purposely made it somewhat smaller in the statue. The trunk appeared to be somewhat too long; and the legs were thought to be a bit too short. This latter fact has always struck the eye of the simplest layman, too, particularly in the case of the naked female body.

What the eye grasps here, however, is not the arbitrary demands of transient taste. There are basic relations here which can be formulated directly, mathematically. For example, the so-called "golden section" plays a rôle in it, according to which the shorter part of a line is in the same ratio to the longer part as this longer part is to the whole line. In our technology, for example, all our windows, all our book sizes and a thousand other things are made according to this golden section, which invariably exerts an unconscious stimulus of greater pleasure on our eye. The several parts of our naked body, as made by Nature, are already subject to this same relation to a high degree; and where it does lag behind somewhat, the artist, with the law in his own eye, simply feels himself qualified to help out.

Mathematical regularity or irregularity in turn depends on this: on the one hand, to what degree Nature has succeeded in bringing the demands in the way of work in a living body into such a united harmony that all organs, when fully developed, will stand to one another in this purest relation without any one-sided overburdening; and on the other hand, to what extent Nature has been able to file

off and master old hereditary influences, old and in part contradictory ancestral material.

The naked human body, as it stands before us to-day in its noblest civilized form and with average anatomical measurements, is on the whole undoubtedly a truly magnificent performance in the way of harmony of the demands on it and the corresponding harmony in the relations of its own structure. And only slight "undissolved spots" still make themselves disturbingly felt. Thus, there is as a matter of fact an insignificant shift in proportions in the one-sided giant size of the brain and, thereby, in the degree of the skull's curvature. This gets really bad when the powerful head of a thinker is enthroned on an undeveloped, narrow-chested, weakly muscled body. This defect can be almost entirely eliminated by a healthy constitution, consistently built up on substantial nutrition in youth and continued gymnastic exercising of the muscles, in the actual normal case of functional efficiency of civilized man as we need him and as we hope to have him as against the temporary victory of the malformed, sedentary indoor creature. On the other hand, we shall have to ask ourselves on some other points, whether in our case too developing Nature has completely finished with the heritage from ancestral conditions of a different character, which the stubborn force of heredity had piled on us too from the very beginning. And right at this point the leg and foot region becomes fraught with meaning.

The monkey, as an extremely one-sided, grasping and swinging arboreal animal, is increasingly tailored to the measure of disproportionately long arms, a squat trunk and short legs. In the case of man, the arms are shortened, while the trunk steps out beautifully upwards and at the same time the legs, as the stateliest longitudinal part of the whole, build up the body erect. The artistic ideal type merely seeks to bring the latter into ever purer proportions, by lengthening the legs somewhat. Does it not seem as if art were striving to eradicate a last trace of monkeylike nature here, at the same time establishing the fact that such a monkey remnant still exists in us? In this sense, however, the real human foot must give you something totally different to think about.

Let it be said in advance, that this naked human foot in itself is by no means ugly. Artists' eyes have at all times found it fascinating, and have admired the graceful, fine spiritualized element in it. Our modern civilization has unfortunately gone almost so far with its obstinate covering up of the body as æsthetically to breed

nothing but the face any more by amorous selection. How often does one meet a girl with the prettiest face in the world, and at the same time the worst sort of a malformed, deteriorated foot, like a peripatetic example of the fact that this incongruity is the result of long continued, completely one-sided ancestral breeding, only toward one side and with the total neglect of the other side. The deterioration of the foot progressively expresses itself in turn in the awful sloppiness of the gait, with which a part of our feminine world which does not indulge in gymnastics and sports unfortunately shines.

In the statues of antiquity there already appears a growing fondness, however, for giving expression to and even exaggerating the freely mobile, toying, playful element in the naked human foot; the detached position, half or wholly in the air. Particular attention was invariably paid to the big toe in this connection; it forms the head, the face, the spiritual centre of the foot, as it were, just as it expresses feelings particularly strongly—erotic excitement, for example.

But all that does not preclude this naked human foot, for what after all is undoubtedly its fundamental purpose, containing a technical eccentricity, even a direct paradox. It is probably the most curious walking foot in the whole vertebrate realm, with its big toe, its arched sole and the way it is set up askew on the heel and the ball of the big toe. A foot like that has a twofold technical occupation. It is a base, the carrier of the weight of the body balanced above it; and at the same time it is a thruster, striking the ground in the course of locomotion. Where natural evolution could serve this tendency consistently and unchecked from the beginning, it went a fixed and best way in its highest vertebrate animal kingdom, almost without exception. Nature made the end of the foot a perpendicular, hard knob under the leg for a support and for striking the ground. At the same time, the body of the foot was raised up and, together with the heel and the sole, was drawn as much as possible into the column of the leg itself. It placed the centre of gravity as near the middle of the fan of toes, which originally existed everywhere, as possible; in the third and fourth toe as a unit, or in the extreme case entirely in the middle toe even. And then it enclosed the actual supporting and striking tip of this dominating middle ray in a hard butt-end—the hoof. You have the extreme peak of this technical line in the horse, which runs on the single

middle toe, which the hoof encloses as a solid mass for striking the ground. Nature lets a race horse with its colossal bodily load whizz along in a race and win on four fine balancing points of that sort.

You can see how practical this method actually is from the fact that we have imitated it for our own foot with our civilized technology, in a makeshift form which is as hideous æsthetically as it is culturally victorious practically everywhere, at least to-day. Though it is horrible to look at, it artificially gives us the solidity and unification of a lump like the hoof, and the heel about brings the striking and supporting butt-end perpendicularly into the axis of the leg. The very fact that we first had to happen upon the shoe with the aid of our implemental civilization proves that something was not in order here with our naked foot; that nature's technology somehow or other lagged behind in our case.

Of course you may interpose that from then on the matter was technically regulated by man; that on the other hand, from the standpoint of the harmony of all parts of the body without going to extremes in forming organs for one exclusive purpose, our naked foot was to be praised because it did not become a real equine foot. I grant that. But why, then, without going to extremes, does it not show at least the fundamental tendency of the organic solution, too, in a simple form, as a human foot with a sole and five toes, by at least placing the centre of gravity in the middle? Why is man's middle toe not the "big toe," from which the others descend at right and left like the pipes of an organ?

Instead of incorporating this fundamental form, it actually makes an utterly arbitrary move, from the viewpoint of the walking problem, in the toe zone; it makes the innermost toe, which is the thumb on the hand, the "big" toe and then it lets the organ pipes descend obliquely from here outward.

Here lies nothing that is simple, nothing that is usual; but the odd thing in the human foot manifests itself here. And from the standpoint of the technique of walking, there is as a matter of fact only one solution; that in this case, the harmonious evolution of the human foot has not been able to this day completely to overcome an old hereditary influence, an ancestral characteristic in that sense.

What kind of a "heritage" that alone could be at this unambiguous place is clear as day. That liberated, playful, spiritualized something, which the artist has at all times involuntarily admired about our big toe beyond all technical pedal purposes, extends significantly

beyond the usual degree in individual cases. Compulsory exercise increases the mobility of this strange toe to such an extent that poor human beings who were born without hands finally learned to handle a knife with the big toe when eating, and a brush in painting. It is easier to write with it than most persons suspect, and produces the same individual, characteristic handwriting of the person in question, even if in wavering form. The very small civilized child too betrays a born gift for this art of grasping with the toe, which afterwards is customarily lost again. You think of the fundamental biogenetic law which points more strongly in infancy to ancestral characteristics! It is irrefutable: the pace of ancestral heritage, which your foot has not completely digested till this day, can be nothing else than that its big toe was once upon a time a thumb, according to its function, that it was the integral part of a genuine monkeylike "prehensile foot." As the foot as a whole became a walking foot, this toe continued to stand still in the organization, like a fossil. And its stubborn existence checked the general transformation of the foot. It worked that way, too. The heel, the springy superstructure of the whole, the remnant of the ball of the thumb-toe gradually afforded a support with which one could work. But the old climbing toe towers up in between, unchanged, to this day.

Involuntarily one tries to figure out why things happened that way here. Does this stage still lie relatively close to us, so that with this remnant we are looking into the process of our coming into being, into the transformation itself? Or was the exact opposite the case; was man already too old, too fixed, when he reached this turn, to be able to carry out such a decisive revolution completely? Or lastly—and this seems very plausible—was there a long intermediate phase, during which climbing and walking both continued more or less side by side and alternately, so that, as a result, the foot adjusted itself to walking but at the same time could not discard the movable thumb-toe for a long while?

Turn as you may here, in any event, it is the monkey foot which rises up in this connection as a necessary stage in the origin of the human foot; which bobs up out of this foot of to-day, in order to place itself historically behind it as an absolutely necessary prerequisite. Man's walking foot of to-day is still nothing else but a climbing foot, more or less laboriously and imperfectly transformed for walking purposes; in other words, a monkey foot!

To imagine the matter historically, to imagine that a monkey changed from a pure climbing life to walking on the flat ground, very slowly and tentatively at first, then ever more successfully and persistently, is not the least bit utopian, when you look somewhat more closely at certain monkey habits of our own days.

Man has been called the universal animal, fit for anything on earth. In the usual sense, this only holds good for man in possession of civilization's implements, which already are almost universal. Purely physically, he has become a rather stiff fellow throughout, at least in our higher civilization of to-day; just because this civilization has relieved him of so much of his burden. If you want to see the human animal once again at its best among us, in the matter of purely personal motor power, you must go to school to the clown and other circus folks, who are still salvaging a thoroughly noble gift of mankind. Where the old power is still exercised, as there, I keep on marvelling at the original agility of our race. The monkey, too, possesses this purely physical gymnastic gift, although essentially only developed in its leaping and climbing phase. But it would be unthinkable that such a climbing genius as this arboreal monkey and such an intelligent one at the same time should not be able to help itself along dexterously on the flat ground somehow. The circus artist shows you right off the bat that one can walk on one's hands, too. It is equally clear that monkeys keep on requiring the ground, if only as a connection between trees or thickets which are at some little distance from one another. Entire regions of the landscape are characterized by such undergrowth. But there are also bands of monkeys, which habitually inhabit more or less naked rocks, where climbing and walking everywhere change over into one another. And Schillings has vividly described the baboons of the East African steppe to us and shown us in pictures how all day long they roam the grassy plain, far from any tree.

The most obvious thing is that the "four-handed" animal should walk on all fours, should walk on its hands in front as well as behind. But almost purely hind-hand walkers from force of habit already occur occasionally among the half-monkeys, as we said before. And funnily enough, it was an extreme feature of this very tree life which more and more forced them to walk on two hands on the ground; namely, the increasing length of the big arms with which they swung themselves from branch to branch. When a creature with short legs and long arms walks on the ground on all fours, it

must quite automatically and gradually come to assume a more and more erect posture. If the arm is as long as trunk and legs put together, then the trunk must raise itself above the legs, so that the hand can reach the level of the foot for the purpose of propping up the body. Walking on all fours becomes hobbling, the gait being really erect, and the long arms serving only as crutches. That is the way the anthropoid apes, the orang-outang and the chimpanzee, really walk over the smooth floor of their cage in the zoological garden, and they hobble along, loosely supported on their hands, palms down, and like it so much and do it so cleverly that you see at once it is a very old custom with them out there in the open. These anthropoid apes can do it differently, too, on occasion. The kind which possesses the longest swinging arms and swinging hands, the so-called gibbon of tropical Asia, which has such extremely long swinging limbs that they threaten to become too long even for this hobbling gait, already walks on the level ground like a human being, entirely without crutches and with its arms free, quite mechanically.

On the basis of pictures which were irreproachable, I was formerly of the opinion that, at least in individual cases, the gibbon had to keep its balance by raising its long, dangling arms above its head, bending the hands downward and then staggering backwards, flat-footed despits its thumb-toe. That may occasionally be the case with some varieties and perhaps also with some individuals. But in any event I have meanwhile been able to observe a whole herd of extremely healthy and happy gibbons at the beautiful zoological garden in Breslau, freshly imported by the physician, Neisser; and among them I quite unambiguously saw an extremely easy gait at a quick pace, on the hind legs, and without placing the arms in any particular balancing position. Their short fur which fitted on the body like silver-grey tights with a black facial mask, gave these skinny fellows a something that reminded you of a group of undressed schoolboys coming splashing along on the board flooring of a bath, somewhat awkward and with their feet slipping in their unaccustomed nakedness. And then, up the tree again, their hands flew from branch to branch like hooks, without any use of the thumb whatever, and their leaps were incredible, particularly in the accuracy with which they gauged the distance through the air; but alongside of this, walking on the ground seemed to be an art that was just as much a matter of course with them and one that had been practiced countless times. These same gibbons will sing you

a little love song, which is the musical scale rendered absolutely correctly. What a very little it would take, just a little something special, for a singing animal like that to tie up all the various sounds of emotion and feeling, the alluring and warning cries which it possesses, into a very primitive language. It required only a certain amount of mental progress to do so. In this connection, the brain of these anthropoid apes far surpasses anything that has been otherwise achieved in the evolutionary chain of living beings below man!

§ 11

To be sure, I do not believe that the anthropoid ape, as you still encounter it on earth in such characteristic types as the gibbon and the orang-outang, the chimpanzee and the gorilla, would itself still be capable of taking this step, even if you offered it more space and time than man, with his rapid extermination already leaves to the rarer animals as it is.

Right at this point you hear the old question, which the layman likes to put as a poser and with which he sometimes hopes to overturn Darwin's whole doctrine (as if that were so easy!): why does not a gibbon or a gorilla become a human being to-day, right before our eyes, by some additional new growth of brain; or why, at least, did the transition not take place long ago in their case, during the many thousands of years that we human beings already exist?

The answer is not hard.

Every step of mental progress in the direction of values, such as a genuine language working with concepts or the invention of implements, would have to make good in a brain that was physically bigger and more developed, in short, in a brain that was still more like the human brain. For this to become possible, the skull would have to experience an enlargement and become correspondingly vaulted.

The skull of these contemporary apes just conversely happens to be very much occupied in a downward and forward direction, in a highly striking fashion. You need only look at the skull of a gorilla alongside of a human skull, to appreciate how gigantic is the lower jaw, how enormous the snout and how extravagantly the rows of teeth protrude. The material of the skull has been utilized at this point in such a manner that one cannot conceive how any further building operations could take place above as long as this condition persists down below. For an iron law, which old Goethe, as an acute anatomist, had already clearly comprehended, everywhere governs organic construction and rebuilding operations, in this fashion: a certain economy must be maintained; a definite amount of material, which cannot be arbitrarily exceeded, has to be got along with; if one

part is to be reinforced, another part has to give up some of its own material and space for that purpose. In many cases this law of economy in the household of life is simply a result of the simple law of gravity; if a part which heretofore was small were suddenly to grow gigantically and at the same time the gigantic size of some other part were to persist, the whole would no longer maintain its equilibrium; the body would break down as the result of the shift in its centre of gravity. If you were to imagine the gorilla's colossal snout portion and its necessary supports in the whole skull for the corresponding colossal muscular apparatus combined with a human-like bony dome of the upper part of the skull bulging out, you would obtain a head which even the strongest gorilla could no longer carry and move.

This whole one-sided monkey face would therefore have to be whittled down its first line in order to obtain a free hand for building the superstructure. Tearing down the old building, rebuilding and putting up the new structure in a very thorough manner undoubtedly would not only require a very long time, but it is a question whether it would still be thinkable at all. A transformation brought about by use, such as making a human foot out of a monkey's hand-foot, would be child's play compared to that. Above all, you must consider the following in this connection. The enormous development of the snout and jaw parts in one of these monkey skulls has a definite, concrete purpose for the animal in question. They serve the distinct employment of this jaw apparatus. As biting organs, the jaws belong to the ape's most important technical organs, the most important implements grown fast on it. Their rôle as a defensive means, as a weapon, is particularly outstanding. Above all, the canine teeth which are large, and in the case of the chief defender, the old male ape, are positively gigantic, serve the purpose of a weapon. They particularly condition the squeezing forward and the snout-long prolongation of the set of teeth. The muscular apparatus that belongs to it, the structure that pulls the wires and works this attacking machine, is correspondingly developed as well; and it, in turn, requires a reinforced bony support in the region of the jaws and the surfaces radiating from them. Practically the entire head is hitched up in the ropes and chains of this machine. The head of the ape is a fortress, and, according to economic practice, the bulk of its material has been put into the outer walls and its guns. You would have to raze all of that, in order to be able to

begin building a humanlike brain-pan. The fortress would first have to be made defenceless against the outer world, the stones of the battlements, to stick to our picture, would have to be torn down, the guns dismantled and melted down, in order that a lofty tower, in itself undefended, could be erected in the courtyard of the old castle with this new material at the monkey's disposal. Let us say, a big library tower (since a brain with greatly strengthened memory and reinforced associations is to be lodged in that tower, after all).

Now you may say that this library would of itself help out later on, by producing (with the more intelligent brain) an entirely new defensive technique (the technology of human implements) at a certain stage of maturity, which would make the former close fortress walls and guns just as superfluous as if some wise Archimedes had one day invented airships and electrical weapons that worked at a distance, as a result of his scientific research in the library room of a real, old feudal castle. Yes, but it would only be the completed library tower that would deliver the goods, after all. Until it was completed, the castle would really be defenceless! And, according to everything we have so far seen of the workings of natural utility in these various animal stories, it would, in a certain sense, be a logical paradox if something, which was useful in the struggle for existence, which manifestly was contrived here as being necessary, like the ape's canine teeth, were to be razed in favour of a sudden new development at a different place, in the upper part of the skull, in the consequences of which (higher intelligence and implemental technology), a progressive step of value in the struggle for existence would have lain only very much later.

Of course, if you could say that one day intelligence grew to such a high degree within the existing fortress and under its protection, that the technology of implements was invented by it, and when that was attained, the walls could be razed and the canine teeth discarded, that would be logically correct. But intelligence, with its big brain, only became possible by the antecedent growth of the skull in the region of the brain, which made the necessary room, and by building that inner tower; and to make this possible, the destruction of the defending fortress walls, of the canine teeth, was first necessary. You would, at the very least, have to invent some very particular separate cause for this destruction, and one with which the whole matter had gotten under way; something which for its own sake in first line and independent of any later intelli-

gence that would result, had made these defensive teeth superfluous and had led to scrapping them.

A special separate cause like that positively cannot be seen even among apes of the type of the orang-outang and the gorilla, for they still need their biting defence to-day. If by chance the beautiful book written by Alfred Russell Wallace, the traveller, and Darwin's first champion, about the Malay Archipelago ever happens to get into your hands, perhaps you will look at the frontispiece of Volume One, which shows an old, gigantic, man-size orang-outang holding a naked native of Borneo in its brutal embrace. While the ape forcibly presses down the spear (man's implemental weapon produced by intelligence) with one hand, it clutches the human body by the left shoulder with the other hand and at the same time sinks its terrible teeth into the right upper arm. The poor Dyak (as these savages of Borneo are called) was on the point of succumbing to the old monkey fortress' means of might, despite his brain and his spear, when he was with difficulty saved, and he never recovered the full use of his arm. The canine teeth of the old baboon males, too, are more powerful even than those of the leopard, the ape's most enthusiastic foe; and a knight-errant like that, with the outer works of its citadel still unrazed, is purely physically the superior of a poorly armed human being, too. Since this human being has a gun in his kit of tools, it is naturally all over with the ape's might, just as with the lion's and the leopard's; but that only touches upon the ultimate victory of intelligence and implements, about which no doubt whatever exists.

From this very train of thought, however, I consider it highly improbable that man himself ever descended directly from a baboon or from one of the anthropoid apes that are still living, such as the gorilla and the orang-outang.

When it is said that man is descended from the monkey, that merely means, from mammals of a more specially monkeylike sort within the broad scope of the class. Man most certainly descended from creatures that once upon a time climbed with a monkey foot; creatures that we would have to include among the monkeys in our system of classification, according to their essential structure. Getting closer home, we still have a choice, not only among all the creatures of this fundamental type that are still living, but of all those that ever lived on earth, and that are now extinct. That and nothing else was Darwin's own opinion, as he set it up for the first time.

But who, of all the countless people who wag their tongues about Darwin to-day, ever reads his important book about the origin of man, which continues to be the most intelligent thing of all that has since been written on this subject!

Man's direct descent from them is quite out of the question for the bulk of those baboons and their closer associates that are still living, if only on account of that matter concerning the placenta (the formation of a secondary root in the womb) which clearly shows that a side shoot branched off very early here on the big genealogical tree, and one whose specialties in this respect not even the anthropoid apes of the gorilla and orang-outang type followed.

Of all the anthropoid apes, both the living ones as well as the few fossil forms known to us, that gibbon, which walks upright and sings so prettily, has actually the greatest anatomical resemblance to man. At the beginning of the diluvial age, when genuine man was certainly already existing with a very primitive culture, that mysterious creature, which we unfortunately know only from insufficient fragments of a skeleton so far, the famous pithecanthropus, was still living on Java. Two factions are still engaged in a controversy over it to-day, as to whether it could have been a genuine relative of the gibbon of those days, of man-size and habitually walking upright on erect legs, or whether a belated scion of man's forerunner, essentially more monkeylike and, more specifically, more gibbonlike, still continued to live in that far-off corner of the earth at that time. More complete finds alone can decide this special question, finds which, above all, would have to show the decisive part of this mysterious being, namely, the outer fortifications, the front part of the teeth with the canines, and the lower jaw. On the whole, after many years of renewed thinking about these matters, I incline more and more to the view about the gibbon and anthropoid apes in general, which to-day is particularly represented by the splendid anatomist, Klaatsch, that in the last analysis the decisive factor for the relation between man and anthropoid ape is the different structure of the teeth, and that this gives man a special position which cannot be brought into agreement with any direct derivation of man from the known anthropoid apes. Personally I size up the situation at present about as follows.

Without a doubt, man and the anthropoid ape are considerably closer to one another than, say, man and the baboon. Historically

we know remains of anthropoid apes which were already closely related to the varieties living to-day, and which date back at least as far as we can date back traces of a manlike being, even with the most daring assumptions. There is a certain degree of probability to-day, that stones used as implements (those eoliths which we mentioned) keep us on the track of some sort of forerunners of man that were close to the beginnings of a culture, even beyond the middle of the Tertiary. Traces of bones of gibbonlike anthropoid apes, which were built a little more robustly and did not possess quite such long swinging arms, go back approximately that far, too. According to that, nothing stands in the way, historically, of thinking that man evolved directly out of an old gibbon like that in the first third of the Tertiary, the eocene period.

But now it just so happens that man markedly came to possess the very thing which the ape never attained: that structural extension of the upper part of the skull, of the "library tower," with the almost total absence of the fortress' outworks in the jaw region: our human teeth are veritable peace teeth, with the most harmless canines in the world. If the anthropoid ape, from which man was supposed to develop, originally had the defensive jaw armament as the others of to-day have it, some special cause at some time or other must actually have subsequently eliminated it again. You would have to imagine that this particular prehuman ape, as we may call him, had at that time gotten into some sort of a sanctuary, thanks to some geological dispensation or other; a land without any particular dangers or attackers, where it could let its weapons rust and its outer forts go to seed for a longer period of time. And therefore the upper part of the skull, the tower of intelligence, could have been remodelled and enlarged undisturbed.

A whole lot of things are possible in such distant days of the earth's history as those into which our contemplation would have to lead us at this point. Such sanctuaries, such "paradises," where a race of animals is relieved from the rougher, tougher struggle for existence, as it were, for long periods of time, so that they can abandon certain weapons, are by no means Utopias invented on purpose.

There were such natural sanctuaries, when man first came to know the earth better; and they already existed in hoary, primeval times. They persisted on numerous oceanic islands until the coming of civilized man. Defenceless animals, like land turtles, grew up to

be colossuses, with no foe to attack them. On Mauritius, a pigeon, the dodo, developed to the size of a turkey and even discarded its wings as being useless, for a long time threatened by nobody; later on, when hungry sailors discovered this sanctuary, this lucky bird had a tough time of it; it was rapidly exterminated to the last dodo. Even a gigantic region like New Zealand was (for millions of years, in all probability) a veritable birds' paradise when the first human settlers arrived, in the sense that there was not a single mammal in the land which could lay snares for the feathered tribe; here, too, birds incapable of flying (the kiwis and the giant moas) came up in the world amid this good asylum fortune. New Guinea did offer chances that were at least closely related to this. Madagascar is still a veritable paradise for half-monkeys to-day. And, furthermore, the whole mainland of Australia never possessed any genuine beasts of prey for as far back as you can go historically. And it is fairly certain that for more than a million years South America had no cats and bears; the big predatory animals of this sort first immigrated from North America over a newly formed land bridge.

Various characteristic phenomena repeated and repeat themselves again and again in such an animal sanctuary. In addition to the conditions of defencelessness that comes about, animals that hitherto were small grow large in it; giant turtles and giant birds without wings developed; at a time like that, there were sloths and armadillos the size of elephants in South America, and on Madagascar there were half-monkeys as big as a man. Animals that hitherto had strictly made their hiding-places in branches of trees, boldly set foot on the ground in the sanctuary; the kiwi, the dodo pigeon, the arboreal sloth, for instance. A more or less exuberant production of luxuries took the place of the discarded weapons. Gorgeous colours for adornment, fine feathers, gay and ornamental appendages to the body, dancing and playing customs bobbed up in connection with the extremely lively love-life; we shall go into this phenomenon in greater detail when we discuss the love-life of the birds of paradise.

The study of these sanctuary factors in the evolution of life on earth, where the tough struggle for existence is temporarily suspended and natural selection could adjust itself to other ways and other motives, is an exceedingly interesting one; and the whole train of thought, as was said, is by no means utopian. Why should not some island region or a very isolated land region have existed in the eocene period (in the first third of the Tertiary) in which a race

of gibbonlike anthropoid apes found a sanctuary like that; a race which, in opposition to all other varieties of higher apes that continued to exist on earth, experienced all those resultant effects of peaceful life in the sanctuary, relieved of its burdens?

However, if you want to conjure up such distant pictures in unexplored regions for man's origin, there is one thing that might be added.

It would also be thinkable that this progenitor of man, despite its monkey nature, had no particularly powerful canine teeth from the beginning; but that it possessed a converse tendency toward a larger dome of the skull (toward building a tower, in the sense of that image about the citadel).

It certainly is a striking fact, that the human teeth to-day show absolutely not a trace or remnant, nor any after-effects of a former gorilla-like outer fortification. You still have the old monkey handwriting so unmistakably in the eccentric big toe of the human foot, despite all the intervening time. Why was not something preserved in the jaw regions, too, at least as a little Satan's tail of the original state, which still might instruct the knowing? The Australian of to-day does not evince a tendency toward canine fangs any more than does the civilized European. The prehistoric Neanderthal man of the Northern ice-age, whom we know from so many recent irreproachable skeleton remains, still noticeably has characteristics in other respects, which clearly lead away from all living human beings and back to a more primitive and doubtlessly more monkeylike formation at the particular spot. For example, his brain turret, which was already fairly well developed (for these people already possessed a culture, buried their dead, etc., as one now knows for a certainty) was additionally protected over the eyes with a sort of special rampart, a bufferlike defensive bay in the form of thick bony ridges. But in the matter of canine fangs, you descry not a trait pointing backward here. A fossil human lower jaw, that latterly became famous as the testimony of the "Man of Heidelberg" and probably belongs to the last period of the Tertiary, still unmistakably shows a few more monkey traits that the genuine Neanderthal man, at the rear part of this very critical region, as far as the jaw-bone as such is concerned. Here an uncle who was a stage older appears to have continued to live until that time around Heidelberg; but strangely enough, everything is eminently human in front; despite the ape-like absence of the chin, the jaw does not protrude more strongly, as a

citadel, and the teeth are as humanlike as is imaginable in such an old-fashioned bony base.

Conversely, however, this set of human teeth, as it still is to-day, has an undeniable primeval trait to the eye of the anatomical specialist; it is reminiscent of the oldest, simplest mammalian teeth, the normal basic design, as it were, from which all the specialized variations in the different groups of mammals first developed; a set of teeth, such as you still see more or less clearly preserved in the stage of the insectivora, of the hedgehog and associates; a very efficient set of teeth on the whole, although calculated for relatively small animals throughout, but in which the canine teeth are not emphasized in any particular rôle as weapons nor in size.

Might it not have been possible that some individual forms had continued to persist from the beginning, from the half-monkey to the highest manlike monkey type of olden times; forms which consistently kept this original set of hedgehog teeth without powerful canines, among the monkey properties which they had ever more energetically achieved?

Perhaps they were small creatures, which for a long while kept the insectivorous mode of eating. In that case, man would have originated from a monkey group which still continued to cling stubbornly to this original set of teeth, even at the anthropoid ape stage. It would have increased in size, climbed down from the tree, made a walking foot of its climbing foot; but in the matter of the teeth, it would not have had to learn any new tricks.

Although in the matter of teeth, too, our gibbon does not exactly belong to the apes with "extreme outer works," one would have to reconstruct the apish ancestor of man somewhat differently than just after the gibbon model, according to this idea. In its snout portion, this ancestor would already have been actually more similar to a human being than all the anthropoid apes that continue to exist to-day.

If you want to consider the general anthropoid ape stage as an historical unit, at least a conditional one, and there is much that speaks in favour of this, then in any event you would have to address this special human ancestor with his "original set of teeth" as the most primitive form, in a certain sense; and in this remote connection it would undoubtedly be possible to uphold the somewhat paradoxical proposition that the anthropoid apes of to-day are descended from man, rather than the reverse. That again would

explain why the gibbon's embryo, as we know it from Selenka, still looks so astonishingly humanlike at a certain stage, the similarity of the facial profile, for example, being much greater than in the case of the new-born gibbon. And again it would explain why the young anthropoid apes generally look more like human beings than do the fully grown ones. Here we would have the original genuine relation still expressed to-day in the language of the fundamental biogenetic law.

Several of the very low monkeys related to that American sapajou still significantly teach us to-day that it is in itself nothing so very unusual to imagine a monkey which originally had and continued to keep a less developed snout and in return manifested an unmistakable tendency to utilize the material, which thus became available, at the upper concavity of the skull (in other words, for the purpose of building that decisive tower of intelligence). They are assuredly neither the direct, apish ancestors of man nor are they even anthropoid apes, but they still have astonishingly small snouts to-day, clearly an old heritage, and on the other hand they have high, vaulted crania with an extraordinary lot of room for the brain. The so-called "Death's Head" monkey of our monkey houses, a cute Brazilian, whose Latin name, *Chrysothrix* (gold hair) clothes it much better, is the most brilliant example of this sort. Its cranium affords so much room that you could truly imagine the brain of a dwarf human being developing in it, as far as space goes; that has not happened however. But assume a similar favourable old tradition regarding cranial construction and growth to exist in the case of a real eocene anthropoid ape, whose brain, which is already more strongly developed as it is, needs nothing more than just this available space for developing; let it at the same time become permanently large and permanently climb down to earth from the tree, and you would come upon man without a hitch, and without directly needing the gorilla or even the gibbon. These would rather be the descendants of another wing existing at that time, which conversely enlarged and strengthened its snout fortress in principle, and thereby determined its fate, so that to this day it has never been able to arrive at that significant "tower."

I believe that this view, which seems to me to be the more plausible and simpler one in the end, does not have to dispense with that pretty idea about the sanctuary, in fact, that it cannot be dispensed

with very well, if one wants to reconstruct the old fairy-tale of man's origin quite logically and clearly.

The fact that a branch of monkeys stuck to its old, weakly armed set of teeth without experiencing the compulsion which continued to breed canine teeth in the others, right on to such extremes as the baboon and the gorilla, points in any event to some locally favourable situation, which must have lasted a very long time and throughout different stages.

As long as merely small, shy monkeys of the stature and mode of life of that little "Death's Head" monkey of the golden hair were involved, perhaps the dense foliage of the great jungle trees afforded sanctuary enough everywhere. But that a monkey like that should have risked being down on the level ground as a regular thing, particularly as during its necessary transition period, it was bound to be weak in the matter of walking at first; that its bodily size should have increased, developing to human proportions, without feeling the necessity for a more powerful set of teeth as a weapon; all that has something improbable about it under ordinary circumstances fraught with threats and dangers, while at the same time these same progressive traits are unmistakably typical sanctuary traits. In any event, I believe that the scene of this origin of man was a land where there were no leopards lusting for apes and no other big beasts of prey, while a certain abundance of food otherwise greatly relieved the burden of the strenuous struggle for existence and stimulated the production of luxuries.

I cannot get rid of the conjecture that the oldest, decisive turning-point in the development of the brain (coinciding with the possibility of an enlarged, vaulted cranium in the sense of that little "Death's Head" monkey) which led to the real first "start toward man," rested to a certain extent on a sort of luxury production.

I already emphasized the fact that among such sanctuary animals generally there customarily makes its appearance a decided tendency toward adornment, gorgeous colours, ornaments in the dress of the body, toward playing, dancing and artistic practices in the habits of life, in opposition to the pure development of offensive and defensive colouring and forms. We shall discuss later on how this comes about, tied up as it is with love-life. In fact, I shall come back to this whole phase in greater detail as it applies to man as well. For the present, let me simply add this much for the sake of clarity.

We invariably see two salient traits in man, in so far as we can

survey his civilization from above. The one is that man, with his civilization, and above all with his implements, with his technology, battles through the brutal struggle for existence on this earth, in the sense of self-preservation and adaptation, more energetically even than any animal before him, which had adjusted itself entirely to offence and defence. In this sense, man has undoubtedly become the most frightful beast of prey that ever existed on our planet, from a certain point in his evolution on, even without the gorilla's canine teeth.

On the other hand, you see this same man, in at least one-half of his civilized work, go after things which are not by any chance of inferior value for him than those other things, which on the contrary first come to constitute the real flower of his civilization, but which are undeniably luxury products, from the standpoint of the simple, brutal struggle for self-preservation in the harsh straits of existence.

Man goes in for art. He writes poetry, paints, makes music, and sings. He dreams, plays, amuses himself, lives and moves in a "world of trivialities," which has absolutely nothing to do directly with the material struggle for existence, but rather only really begins where the latter ends.

Man is further a thinker, a brooder about himself and the world, a seeker after truth from the pure urge to know. He creates mythologies, religions, philosophies and sciences. At one point this is intimately connected with that free play of the imagination, as art gives birth to it. At the opposite corner it touches practical questions as well. Philosophy answers, or should answer, burning wants of existence; science continually improves the external, technical means of combat. In particular, the deepest, most essential trait in religious, philosophical brooding as well as in unselfish devotion to "scientific curiosity" likewise emerges from this sober, practical side and extends far beyond it into the region of "luxury production."

These things are by no means activities of highly civilized man of to-day only, whose gigantic technical mastery of the struggle for existence leaves him room for such over-production. The wildest savage already lives and moves and has his being in play and art; and he possesses most comprehensive mythologies. The cave-men of the diluvial period already painted the walls of their caves with

animal pictures in bright colours, and embellished their implements artistically. The skeleton of a boy of the Neanderthal race, which was recently dug up in the cave of Le Moustier in France, was not only carefully buried, but the inclusion of weapons and food with it, quite in the manner of the burial customs among savages of to-day, clearly indicated that even these primitive human beings, as "thinkers," already believed in a life after death, in the continued existence of the soul; the weapons were intended to help this soul on its way, the food to feed it. Here there is everywhere clearly a something which man must have begun to develop very energetically, very deep down, at a very early time.

But you may not say that an absolute gulf separates man from the animal because of these traits. The harbingers of our art clearly run through the animal world. Among the higher animals, traces of a life of the imagination, the supreme basis of the whole, already become quite distinct. Just think of a dog or a bird that dreams. And yet it again remains true, that in these very activities, as man has pushed them into the foreground and developed them, lies what is really the specifically "humanest" element of his civilization and the element that is most peculiar to his whole nature. Not man, the beast of prey, developed far beyond all leopards and baboons by virtue of his technical means and knowledge, but man, the artist and thinker; he is evolution's real accomplishment in us, he crowns the concept of civilization, the idea of man generally. Where that was contrived, there first was man with all his depths created; man whom we had set out to find in a Darwinian sense, as our goal above; man as the representative of values that extend as far beyond simple self-preservation in the brute struggle for existence as heaven is from earth, as ever art, religion, philosophy can be, and which build up a world of positive happiness and content as the topmost storey.

But these human values are decidedly arts of peace. It is quite impossible to see how the crude struggle for existence could have created them. Since man sets in so strongly with them, right at the start and finds his centre of gravity here to such an extreme degree until this day, I believe that this root of humanity cannot have been merely a by-product of development along the line of implements and weapons, which gradually made man the most powerful of all beasts of prey. A special phase must have existed in our original evolution, which powerfully developed this very side from the very beginning, independently of, even in opposition to, that other side.

Nothing would fit that phase better than the sanctuary idea, pictured somewhat as follows.

A race of monkeylike beings, which has reached the stage of the anthropoid apes of to-day in many characteristics, but which, in contrast to them, had kept a set of teeth of moderate proportions together with the possibility of a greater development of the cranium, by some geological dispensation chanced to get into a land that was both strictly isolated, and very rich in itself, but poor in perils, and it continued to exist there throughout a very long period of time. A long epoch of far-going relief from the burdens of the harsh struggle for existence there favoured the development of its brain, a development that was already strongly stimulated in its monkeylike character, and above all, in the direction of that spiritual luxury production. The life of the imagination, as expressed in play and art, enjoyed a very extraordinary and one-sided boom in first line. Everything that still flashes out in the case of the genuine monkey to-day, half latent, half suppressed and dragged down again into the ugly mire of malice and vexatiousness of the struggle for existence as it is, the monkey's mental agility expressed in play, in its humour, its gracefulness, its inventive gift and its curiosity, its devotion to pure amusement values in situations and combinations without any crude utilitarian idea whatsoever, all this automatically came into very special, very pure, very exuberant bloom here. Leisure, liberation from the mad, headlong pursuit of the struggle for existence at the same time afforded the inner life room for deepening, for clarifying itself. Consciousness took the first dawning step toward reflecting about itself and thereby toward a totally new form of considering external things. Perhaps this step was the heart of man's real origin; the most inward, spiritual act of self-creation, since which the "human being" exists as an absolutely new stage of evolution, beyond all animals.

Naturally, love-life played its big part in things everywhere. Play, adornment and art of primitive peoples, in their content as well as in their spirit, still essentially revolve around love-life to-day. Sexual life, as you know, had most important connections with the preservation of existence in the realm of the "Good Fairy Utility" from the primordial beginning. But at the same time there was always a decided peace trait too in sexual life. This peace trait begins with the first act of the harmonious fusion of two cells in the original occurrence of love, in opposition to the stronger cell killing

and eating the weaker one. Love-life as a whole ever blooms with peace, as it did with the social act of the volvoxes. The more richly it unfolds in spiritual forms among the highest living beings, the more it is dependent on sanctuary times, at least in the individual life and it imperiously makes such periods of sanctuary for itself where none exist, and compels these beings to throw all their material cares of existence overboard for once, during love at least, and live their lives to the limit, as in paradise. How much more must love-life have profited, have become intensified, and have adorned itself in such a sanctuary period of an entire race extending over many thousands of years; in a real temporal "paradise"! Stop to think even to-day, when, despite all momentary economic complications, technology really relieves us to such a great extent of our burdens, what an extent really beautiful, spiritualized love-life, burning pure and bright, would assume among us if we were entirely relieved of all material burdens, if we were entirely free from external cares, if we were paradisians in this sense.

To-day, too, that would undoubtedly bring about a colossal growth of luxury production, above all, a boundless boom in art. And this coming development must already have thrown its shadow before it at that time, it must once upon a time have helped to get man going at all as an artistic being.

And also as a thinking being. Much as you may want to say that love must be at blood-heat and never abstract, love actually has always been a source of deep thinking. Only by this very process of seemingly merging entirely in the other individual, of flowing on (for our spirit ever strives anew toward that old cell act of mingling) and foaming away in the storm of kissing, self-denial and procreation, does the individual first become conscious of his whole feeling of self, of his individuality, as from a high watch-tower. The loftiest thinking brain, the brain of reflecting consciousness, thinks only as one proudly sailing on the hot billows of the blood that surges through it. Whatever heats this wave likewise moves the boat up there more energetically. And in the last analysis, objectively as well, the most important phenomena of life, with which all the thinking soul's philosophizing, mythologizing and scientific searching must inevitably keep on starting objectively, are phenomena of love-life. Procreation and birth are under its spell. The sexual parts quite certainly have been the most powerful prime movers of philosophic thought, and still are to-day, even to our most difficult de-

bates over general views of life. But we also saw how the opposite pole to all brooding about the world, how grey death, in the stage of the volvoxes, was only a creation of love.

On the other hand, such a sanctuary period must have exerted a tremendous influence on the social life of the human animal which was coming into being. Here, too, it undoubtedly proved favourable to peaceful associations and early helped to lay the corner-stone of that which later ever remained to this day one of the pillars of the best in humanity, even in the most savage times of fighting: the inclination to ethical law and order in human relations, to a conscious conclusion of peace among human beings, more or less limited in the beginning, but in the end becoming universal, at least in the form of an idea. After all, Nature breeds similar associations in the course of the pure struggle for self-preservation, as being the better way of regulating things. Love's mingling of cells and social organizations like the volvox were already blindly under its compulsion, and higher up in the kingdom of life they had made good in thousands and thousands of symbioses, formations of herds and animal states. As the very earliest, initial monkey which started to become man, man's progenitor may well have been an extremely sociable animal already, with certain habitual bursts of enthusiasm for mutual help. But necessity alone is not the root of ethics; and a sociable life in a certain atmosphere of comfort, relieved of life's burdens, is bound to help coin social ideals of peace too. And this ideal runs through all mankind in the form of so deep a longing, that it seems as if somewhere at some time in man's history it must somehow have arisen and been stimulated otherwise than merely under the blind lash of necessity.

This lash of necessity then began to crack good and plenty for man as well. For you must of necessity imagine the continuation of the story as follows. After a very long duration, the spell of this sanctuary was finally broken after all, and mankind was exposed to a fierce struggle for existence anew. Where prehistoric culture first rises up in really distinct pictures, we see man right in the thick of a most intensive life and death struggle. We see man, as a powerful beast of prey, at war with beasts of prey. We see him bidding defiance to climatic opposition and changes on the earth. We see him struggling to maintain himself on this earth under the most varied conditions. That already starts and conditions man's cosmopolitan rôle. After they have been driven far afield by migrations and have

become strangers to one another, human races encounter one another and engage in the most savage kind of competitive struggle. No matter how you chose to imagine these things more specifically, whether you want to let man leave "paradise" gradually, by virtue of his increasing and multiplying and by virtue of his intelligence, and swarm out over the earth, or whether you want to draught geological changes and their compulsion, in which the Tertiary was so excessively rich, into service, you must certainly put a rift, a transition, a station, with which the sanctuary terminated, between this later picture of man's origin and that real, paradisiacal one.

This time the vital nerve of things is quite clear: man's intelligence had meanwhile increased to such a degree that he could really ward off the new attack of the struggle for existence by the use of implements, of artificial stone weapons above all, outbidding the beast of prey's teeth, and incidentally by the artificial generation of fire against climatic inclemency. Though man was hurled back anew into a "beast of prey epoch," he nevertheless now came off successfully with the help of his intelligence, instead of belatedly having to seek the way of the gorilla's teeth after all, or wretchedly perishing as a spoiled weakling, like the dodo birds without wings. An absolutely unique sanctuary animal in this respect, the only one of the sort by reason of the capital which he had gathered there, man was now to step out as a fighter and begin his road to world dominion, which in the end showed up all the most seasoned fighting animals of his planet as such helpless "dodos" when they faced him.

If you picture to yourself that the search for and permanent use of a suitable stone for a weapon and, above all, the artificial fashioning of such a stone for this purpose owes its existence in first line to a simple act of the imagination, but one which was magnificent and decisive as progress, the transition follows easily enough.

Imagination, exercised in playing in the sanctuary, now celebrated its practical triumph. And I cannot help having the idea that a closer road may have led over specifically from art, as the more original, the more paradisiacal of the two, directly to the weapon as the new trump in the struggle for existence.

I picture to myself, that transition man of the sanctuary period in his erotic-æsthetic play may already have found pleasure in coloured, shining and curiously formed stones, collected them, employed them as adornment and then gradually fashioned them more suitably for this purpose. I have more to tell you about this form of pleasure,

which goes at least as far as intentional seeking and collecting, in the case of animals which rank very far below the anthropoid ape in the matter of intelligence; namely, certain birds which happen to be called birds of paradise, half in an accidental and half in a genuine connection. In their love-time, they build special nuptial bowers and adorn them with all manner of brightly coloured or otherwise strikingly æsthetic baubles that they can lay their bills on, particularly shining and pretty stones, which every human child would choose to play with too. Might not a very primitive technical knowledge have been gained with such stones for very primitive adornment and play, with such shells, bones and pieces of crystal with which preman too adorned his nuptials; fed at first by the purely artistic imagination, that gave the finishing touches to the material in hand, in order later, at the necessary moment, to furnish the decisive basis for the new purposeful technology in the struggle for existence that started again—the technology of implements?

By "artistic imagination" you do not by any means need to imagine something which is all of a sudden and quite extravagantly injected into the natural course of development. If you want to express the idea purely mechanically, simply say: this was only a necessary phenomenon of correlation in the developing brain, but it happened to be the primary one.

I have a certain fondness for this whole train of thought, not because I want to give art an exaggerated rôle to play in the origin of man, which art does not need, but simply because it seems to me that it results in such simple logic, proceeding from something which already exists in the case of the animal to the thing with which man so decisively outstripped the animal. Monkeys of to-day occasionally use twigs and stones as levers and as weapons for striking and throwing. But one would like to see how the element of love and inspiration came into the use of dead material, even impelling the long chain of generations to it; and one would like to have a closer look at the step that led from simple use for the need of the moment to the work of the imagination, expressed in conscious planning and transforming during quiet working hours, free from the mad haste of the moment. And it seems to me that this is the very thing which the animal's primitive striving for adornment affords us. In that case, to put it in very modern terms, the sword would have been invented for parade purposes first, and only then came to be a genuine weapon; or the diamond ring gave birth to the brass knuckle, his-

torically speaking. Again and again, you find such an alternation of uses running through nature as well as through civilization. And after all, this idea simply flows into the main proposition, which this whole consideration of the subject is meant to set forth: namely, that man did not become man in order to prove himself an even more powerful beast of prey than all the others, but that he first underwent an efficacious process of development as an artistic animal, an imaginative animal, a thinking animal, an ethical peace animal, and by reason of this process definitely and finally opened up as "human being," and then, when it became necessary, became the highest intelligent beast of prey as well. We are already "dreaming" whether the beast of prey in man might once more no longer be necessary some day. Whoever is to-day in the full possession of our civilized education and has the free choice between art, loftiest universal thought, devotion to the search for truth, and noblest ethics on the one hand, and on the other hand, brutal trampling down, the beast of prey's pleasures, wars with blood and torturing wounds, can be in no doubt as to where the original possession and the fundamental wish of man lies, despite all pretty speeches about the "blond beast," which will live its life to the limit. . . .

If our attempt to dream Nature's wonderful dream of the origin of man ever again leads us in the end to pictures such as these, it cannot escape you that the line of true narrative appears to cross old legendary trails of mankind at this point.

The wonderful legend about paradise, with its blooming peacetime garden that murmured over the heads of the first human beings, seems to take shape once more under the search-light of science, far off in the primeval forest of an unknown island of the eocene period. And one day, somehow or other, original man is driven out of this magic wood, too, where he loved, sang, dreamed, and played with bright coloured pebbles and shells, out into rough fields. Perhaps there, too, it was his own courage, surreptitiously eating of the fruits of intelligence, that forced him to start on his wanderings; the wonderful new apple of life, which in truth did not grow on a tree in paradise, but ripened deep in the enlarged skull caves of these new beings as a human brain. For him, too, the fiery sword of a new geological epoch flashed before the gate when he wanted to return home at that time. This Tertiary age burrowed boisterously in the bowels of the earth, piled up new mountain ranges, buried broad

lands under red-hot basalt blankets, split open oceans, drove vegetations and swarms of animals before it, till at length toward its end a paralyzing hand of ice reached down from the poles, devastating everything, while at the same time a period of rain descended on the tropical lands. No angel of the Lord in the legend could have conjured up wilder pictures. The child of paradise now sees itself surrounded by these storms, it gropes its way through volcanic ashes and deserts, the hordes of beasts of prey, frightened away hither and yon along with it, roar around it in the night, endless rain surrounds its scant abode with threatening floods, till at last the horrible wall of ice towers before it. Itself become a beast of prey, it hunts game. It takes cover in deep caves. And yet it saved the light of paradise. In bestiality, in the night, in the cave, the old values secretly remain true to it: art, dreaming imagination, thinking, introspection. Thus does man's endless, thorny, somewhat retarded ascent begin again, which yet sees paradise rising up anew, very far off, as an ideal, not as an easy gift of chance now, but as the result, as the achievement of his own work, on the peak of civilization, reconquered piece by piece in combat with a whole planet. . . .

It is hardly possible that dark tradition in the myths of peoples could have salvaged anything of this historical drama on earth, going back to the primeval forests of the Tertiary itself, even if things really did happen that way historically.

What seems more obvious, and at least just as beautiful to one who sees only an image in all truth, is that the logic in the dreaming human spirit has kept impelling man on to the same path.

Popular imagination in all the generations always saw this opposition of the two beings in man: the being of deeply inward peace, that struggled only for art, thought, philosophy, religion, unselfish devotion to science and love; and the compulsory, blood-stained beast of prey, that stormed with the lion over the dark earth, that came out of this black earth like every other animal, that wretchedly fought for its few years of life, fleetingly, in a thousand straits, and sank back into the earth again. And out of these two human pieces it made a story, the legend of paradise, where man was wholly the one being; and of the expulsion, which made him wholly the other one; and of the struggle for redemption, which at last, at the end of his days, was to bring the robber and the martyr back again to his happy home in the sun after all, where the bloody arms would

become adornments and toys again. What else does our mature thought about nature, which to-day is tracking the evolution of things, do at bottom but reconstruct the fairy tale of prehistoric times from the lines and arabesques of the material on hand, with the identical logic?

There can be nothing in any way disquieting about nodding a friendly greeting to the old Bible picture. A sad aberration of our age, which is unworthy of the genuine spiritual human being in us, sought to forge an eternal norm of knowledge in a very narrow temporal setting out of such folk dreams born of symbolizing logic, and sought to force free science to halt before it.

Only one who has entirely rid himself of such a conception and made himself perfectly free and independent, will gain an unprejudiced understanding of how closely the paths of poetic invention and scientific investigation really do continually touch in the human spirit and how necessarily they must soar to similar symbols from similar simple observation of certain fundamental phenomena, which are present to the mind to-day and which were present to the mind thousands of years ago, because after all they are both guided by the same logic.

But ye, God's sons in love and duty,
Enjoy the rich, the ever-living Beauty!
Creative Power, that works eternal schemes,
Clasp you in bonds of love, relaxing never,
And what in wavering apparition gleams
Fix in its place with thoughts that stand forever!

END OF VOLUME ONE

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